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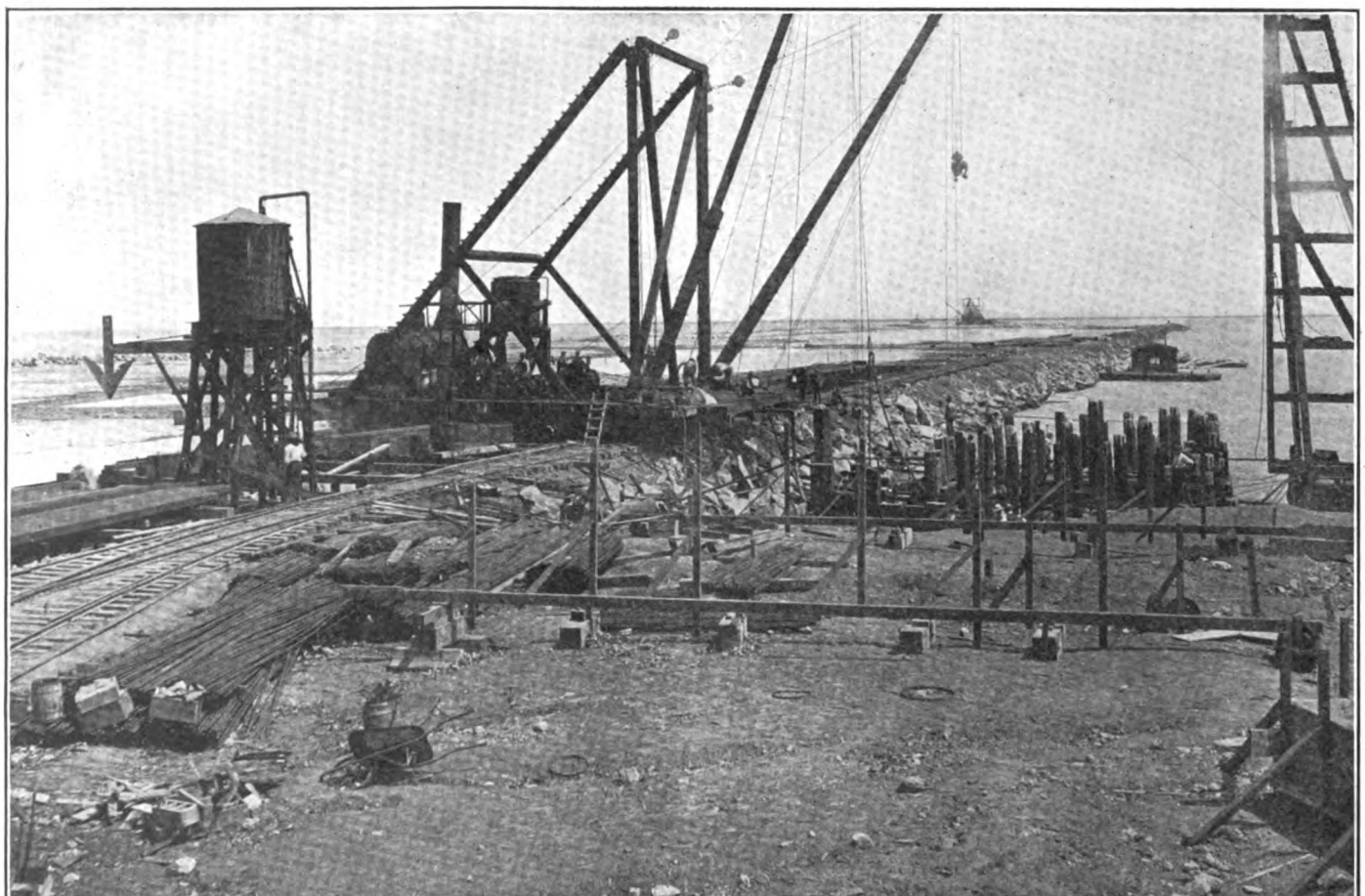

CONCRETE WHARF CONSTRUCTION, LOS ANGELES, MUNICIPAL DOCK No. 1. (See page 30.)

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EDITORIAL

FREQUENTLY a question arises as to the relation between specific and Baumé gravity with reference to petroleum. The following formula given by the U. S. Bureau of Standards for petroleum at 60° Fahrenheit is generally used:

$$\text{Specific Gravity} = \frac{140}{130 + \text{degrees Baumé}}$$

For ordinary field work a reduction of 1° Baumé for every 20° Fahrenheit above 60° is considered sufficiently close for oils around 18° Baumé.

IN the interests of the development of navigation on the inland waterways of California, the Commonwealth Club has sent out a call for a congress for the discussion of this important subject. County boards of supervisors, cities of 3500 or more inhabitants, irrigation districts, and the commercial development associations throughout the state have been invited to send delegates. A committee was organized by the Commonwealth Club some time ago for the study of inland waterways development and a report was rendered at the November meeting. It is proposed now to take up the practical phases of the problem to the end that the wonderful possibilities for inland waterways in California may be brought to the attention of all the people and that definite steps may be taken toward their development. A similar movement is under way in Oregon, and we published in our November issue an article by Mr. John H. Lewis, State Engineer, dealing with the canalization of the Columbia and Snake rivers. California should not lag behind in this important work, as cheap transportation through the development of the Sacramento and San Joaquin rivers and their tributaries would be a great factor for the development of farming and industrial pursuits in the interior of the state. The congress will take place in San Francisco January 15 to 17 and it is expected that it will be attended by over 500 delegates.

NEWS has been received of the completion of the Longitudinal railway of Chile, the ceremony of driving the last spike connecting the northern and southern sections having taken place on November 3. The Northern Longitudinal was built by Messrs. Macdonald, Gibbs, and MacDougall, and financed by the Chilean Construction Company for the Chilean Northern Railway Company, Ltd. The gauge of the line is 1 metre, the total length 440 miles. Work was commenced in April, 1911, and completed on March 25, 1913, ten months ahead of contract time. From the southern terminus, the route lies through a mining region and rises to Balmaceda, 8500 feet elevation, at a maximum gradient of 2 per cent. Thence it descends to Palestina, 2700 feet, and rises to Los Dones, 5000 feet, from whence it descends again to Toco and continues practically level to its northern terminus, Pintado. Its heaviest gradient is 2½ per cent and its minimum curvature 137 yards radius. The feeders and connections are the Taltal railway at Catalina and Aguas Blancas; at Palestina the Boquate branch and at Baquedano the main line of the Antofagasta railway. The

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Southern Longitudinal railway, extending between Santiago and Copiapo was handled by the Howard Syndicate and the work carried on by the Regie Generale de Chemins de Fer et Travaux Publiques. This state railway extends from Santiago leaving the line to Valparaiso at La Calera for a narrow gauge railway which runs via La Ligua to Cabildo about 120 miles from Santiago. From Cabildo to Ovalle is 200 miles over a mountainous region, of which about 40 miles is traversed by rack and pinion railway. From Ovalle to Coquimbo more steep gradients are encountered and then the line descends through a wide valley that presents great possibilities for irrigation. La Serena is but a few miles from Coquimbo and from thence the Southern Longitudinal passes northward to its terminus. The construction difficulties were both numerous and great and the successful accomplishment of the work marks another triumph for the engineering profession and a great step toward the economic development of our sister republic on the south.

GREAT names have their uses and also their abuses. Hero worshipers often find that when the light of clearer understanding dawns they have merely constructed a man of straw. So it seems has been the unhappy fate of the good people of Oroville who named a recently created school district 'Rockefeller' in the hope that this distinction would be the means of procuring for them a substantial monetary donation. Unfortunately, Mr. Rockefeller has thus far proved deaf to their entreaties, and now it is reported that it is seriously contemplated changing the name of the district to Ida M. Tarbell. Revenge is sweet, but it appears to us that the circumstances hardly justify so stern a rebuke. Suppose that this method of obtaining donations should become fashionable. No wealthy man would be safe from the despoiler, with one hand extended in an attitude of supplication and the other concealed behind his back containing the family skeleton. We hope that Miss Tarbell will not encourage the course taken by the Oroville school district by making a donation on her own account.

ON January 1 what is known as the Compulsory Compensation Act goes into effect in the State of California. This is generally regarded as the most drastic employers' liability act that has yet been enacted. It applies to employers of all classes of labor excepting only farm labor, domestic labor, and casual employments. The only exemption from liability is in the event of willful misconduct or intoxication of the injured employee. The act provides for death compensations up to $5000 for each individual. In case of total and permanent disability a substantial pension is provided for life. In addition the employer must furnish such medical, surgical, and hospital treatment, including nursing, medicine, and supplies, as may be required for the period of 90 days without limit as to cost; for death, if there are total dependents, three times the average earnings of the deceased or total payment for disability. Indemnity or death benefit shall not exceed $5000, nor be less than $1000, payable in installments of 65% of average weekly earnings. Both total and part disability are provided for with varying indemnities. An Industrial Accident Commission is created whose awards are final, except that appeal may be made to the Supreme or Appellate court, but the powers of the court cannot extend beyond certain prescribed limits. No

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additional evidence can be introduced and the findings of the commission on questions of fact are not subject to review by the court. Take as an illustration a clerk earning a salary of $100 per month, who is knocked down by an automobile while engaged on his employer's business. If he is killed there is at once a claim against the employer of $3600 in addition to any surgical, medical, or hospital charges; if he is permanently and totally disabled, the employer will be called upon to pay him $65 per month for four years, seven and a half months, and then $40 per month for the balance of his life. The employers' liability insurance companies are quoting rates to employers commensurate with the character of the risk, and provision is to be made by the state for insurance at cost. What the result of this law will be upon industrial conditions in California is open to debate. It is said that in the end the consumer always pays, and while this is undoubtedly true, it will be small consolation to California employers who are compelled to compete against commodities manufactured outside of the state and which do not have to carry such an expense for employers' liability insurance.

MEN engaged in the mining and oil industries of California will be interested in the news that Mr. Charles E. van Barneveld, chief of the department of Mines and Metallurgy at the Panama-Pacific Exposition, has set aside what is regarded as the best space in the Palace of Mines for the general mining and petroleum exhibit for California. It, therefore, behooves the men interested in these two great basic industries to bestir themselves and see that proper advantage is taken of the opportunity thus afforded to them and the industries that they represent. The space selected is under the central dome, and so situated that no visitor to the Palace of Mines can fail to see the exhibit. The possibilities afforded by this opportunity are large. What the mining and oil men of the state will do with the opportunity will rest entirely upon themselves. It is obviously impossible for the Exposition management to collect and present the exhibit. It would appear to be sufficient merely to afford this opportunity and let those interested in the welfare of their state and their industry do the rest. Demands for space have been such that unless definite action is taken within a short time, California's share in this portion of the exhibit will have to be sacrificed for the benefit of those who come from afar and are more enterprising. If the California oil and mining industries were more fully appreciated outside of the state, capital for investment would be much more easily obtained.

San Francisco's Water Supply

After a 12 year struggle, San Francisco's efforts to obtain an adequate supply of pure water have triumphed. On December 6 the Hetch-Hetchy water bill passed the Senate and on December 19 the President affixed his signature, the bill thereby becoming a law. And now, after we have had an opportunity to catch our breath, let us see what this signifies. Mr. C. E. Grunsky, in this issue, points out that the Hetch-Hetchy Act of today differs materially from the project proposed 12 years ago. The Act, as it stands, represents many compromises in which it would appear to some that San Francisco has come out second best. Concessions were made by the representatives of the city that would appear to have been a sacrifice of the city's rights and privileges.

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On the other hand, to have attempted to maintain these rights would have undoubtedly resulted in endless opposition from the government officials and the Turlock-Modesto irrigation interests. It would be but empty satisfaction to the people of San Francisco to quarrel over technicalities while the time of urgent necessity for more water was drawing nearer and nearer. In short, we believe that the best bargain possible under the political circumstances was made, and that those who conducted the city's fight are entitled to hearty approval and support.

We are fortunate in being able to present in this issue articles by Messrs. C. E. Grunsky, M. M. O'Shaughnessy, and Marsden Manson, which discuss thoroughly the many and complex phases of San Francisco's water supply. The creation of the Hetch-Hetchy Act does not represent the end of the struggle; on the contrary it is only the beginning. The real work, first financing and then constructing, lies before us. The $45,000,000 bond issue voted in 1909 was for a specific purpose and in accordance with the Garfield permit. The present Act, being radically different in most of its provisions, will, in all likelihood, require a vote on a new bond issue. As the general scheme for the city water supply includes the purchase of the Spring Valley system, the vote on a new bond issue will probably have to be delayed pending the decision of the court in condemnation proceedings, an ordinance for this purpose having been passed to print by the San Francisco supervisors some days ago. The creation of an organization to handle the work, and the plan under which it will operate is of paramount importance. Municipal work, unfortunately, is seldom if ever conducted along business lines. Political rather than business standards are apt to govern the selection of men and the administration of affairs. How to remove the construction of the Hetch-Hetchy project from politics is the problem. Mr. Grunsky suggests a water board, in fact had such a board been created at the inception of the project nearly 12 years ago, much confusion due to lack of co-ordination between various city departments would have been avoided. Positions on the board should be appointive, not elective, and the term of office should be the estimated time required for construction. Such personal requirements as fitness for the work are obviously essential, and the compensation should be such as to be attractive to men of the highest attainments. A valuable lesson may be drawn from the history of the building of the Panama canal. The confusion attending the early organization with its frequent changes and divided responsibility are still fresh in our minds, and until the executive control was placed in the hands of one man, Colonel Goethals, slow progress was made. How may San Francisco do better than study the method of organization that built the Panama canal and apply it to the Hetch-Hetchy development? If the federal government can spend $400,000,000 for building the Panama canal, and many millions more for the numerous projects conducted by the Reclamation Service, all without the slightest taint of graft or scandal, why should not the city of San Francisco be big enough and broad enough to put aside petty considerations and administer the Hetch-Hetchy project on the same basis? There is abundant precedent both as to what to do and what not to do, and the selection of the course to be pursued will determine whether the Hetch-Hetchy water supply project will be referred to in after years in terms of the Panama canal or of the old City Hall.

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REVIEW OF THE MONTH

DURING what has become known as the 'Holiday' season, it is customary among the Christian people of the world to wish their friends a 'Happy New Year.' The chief charm of this greeting is its cherry optimism, and the great majority of men, especially among the engineering fraternity, will waste no time in vain regrets at the passing of 1913. Popular superstition has designated 13 as an unlucky number, and it would seem to many that the events of the past year have conspired to justify this belief. At a recent dinner of the Engineers' Club of San Francisco, a mining engineer was facetiously defined as "a man out of a job." Conditions in Mexico have been such that this definition has ceased to be a joke, and the general financial depression has not tended to make the state of affairs in the United States much better. The engineer is the advance guard of progress, and without progress the advance guard necessarily languishes. The year past has been characterized by retrenchment on all sides, and the withdrawal of support by financial interests has caused many poorly conceived enterprises to totter on their foundations. In fact business conditions have been ideal for the propagation of cynical utterances.

AS a matter of fact, however, is it not time we caught up with ourselves and took account of stock? Since 1900 have we not been fooling ourselves into mistaking an era of inflation for one of an established rate of increase? The big business of yesterday was expected to be the normal business today. Many manufacturers who were suddenly swamped by a flood of orders, used their credit to the limit in order to provide increased facilities, instead of taking their profits when they could get them and wait for the flood to subside. Then came the New Jersey corporation, otherwise the 'Trust,' the public being the sponge that absorbed the water until the limit was reached. We, as a nation, seem to have overindulged in green apples, and Dr. Wilson with his legislative calomel is trying to help us to recover from a consequent attack of financial indigestion. Money is proverbially timid, and the use of the word money, in this sense, is merely to personify the men who control it. Bankers have become so accustomed to conducting their business along certain established lines that the mere thought of a change throws them into a convulsion. Bankers are not alone in this inertia of habit. The powers conferred some years ago upon the Interstate Commerce Commission were vehemently opposed by the transportation interests, but we doubt if they would today care to revert to things as they were. The Owens-Glass currency measure has passed the Senate and by the signature of the President has become the Federal Reserve Act. Now that this matter has been disposed of, the banking interests will resign themselves to the inevitable, and the engineering fraternity will awake from its sleep and prepare to get onto the job again. A disposition on the part of many so-called 'Trusts' to voluntarily dissolve is another hopeful augury for more stable business conditions.

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ON the Pacific Coast there has already been a marked change for the better. A number of local enterprises that through lack of funds have been compelled to halt in their work of development, have succeeded in enlisting outside capital and may be regarded as having regained their financial feet. It is said that a prophet is not without honor save in his own country. So it seems is the case with many Western enterprises. European capital will play a prominent part in the development of our oil and irrigation projects during the next few years as has been noted from time to time in our news columns. Now that an Act of Congress has authorized San Francisco to develop the Hetch-Hetchy water supply, $75,000,000 will be expended for this work provided that the Spring Valley system is also purchased. While money to push development of power enterprises has been exceedingly scarce, the power and lighting load has increased to an almost phenomenal extent. The day load in San Francisco alone is increasing at the rate of about 30 per cent annually, while through the San Joaquin valley the increase has been nearly 4000 per cent in the last 5 years. It must not be assumed that that is an indication of prosperity for the power companies alone; on the contrary, no public utility can prosper without benefiting the community which it serves. The demand for power means more than a mere substitution of electricity for some less satisfactory method. It means that through lower rates and more satisfactory service countless industries have been made possible which otherwise could not exist. There are those who view with alarm the prospect that San Francisco will ultimately develop 150,000 horse-power as a by-product of the domestic water supply project. We venture to predict that before another ten years have elapsed, there will be a ready market for the city power, all of the private power, and more besides.

NINETEEN FOURTEEN will be a busy year. Its close must mark the practical completion of the Panama-Pacific Exposition in every detail. The opening of the Panama canal will turn the tide of ocean traffic toward the Pacific coast. Immigrants will leave the congested kingdoms of Europe and help to cultivate the vast areas of Western irrigated farms. With every physical attribute to greatness, who can be other than optimistic concerning the future prosperity of the West? On the day when the charge of dynamite destroyed the Gamboa dike, the beginning of the end of the old West was announced. First came the prairie schooners of our forefathers, then the first transcontinental railroad, and now the Panama canal that removes the last physical obstruction between the West and the markets of the world. Happy New Year—and why not? Santa Claus may not have come laden beyond the Plimsoll mark; the stocking may not have been over full; it may even have been copiously darned. But what of that? The seven lean years have passed and the seven fat years are at hand. Let us not hold a post mortem over what has gone before. Like toothache, it is fun when it is over. Face the rising sun with confidence as to what the coming year has in store for us and remember what the whale said to Jonah, "You can't keep a good man down."

ON December 20 the State Supreme Court over-ruled the order of the California Railroad Commission requiring the telephone and telegraph companies to make physical connection

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with independent telephone lines in Glenn and Tehama counties. The reversal was made on the ground that the order of the commission gave the Pacific Telephone & Telegraph Company no compensation for taking its property, and, therefore was unconstitutional. Although this decision, on the face of it, may be considered in the light of a reversal for the Railroad Commission, at the same time it declares that the constitution has vested both the power of eminent domain and police in the Railroad Commission and that the reasonableness of its orders and decrees cannot be questioned other than by the Federal Courts. This would indicate, therefore, that had the Railroad Commission in rendering this order fixed a compensation for the service, no matter how small, its decision would have been upheld.

INTEREST in affairs of the oil industry centre about the presence in California of Messrs. Andrew Weir and R. Tilden Smith, representing the syndicate of London bankers that has recently undertaken the financing of the General Petroleum Company. It seems from newspaper reports that the whole project is assuming vastly greater proportions than the mere taking over of the General Petroleum Company's interests. Should the Weir syndicate decide to exercise the option held by the General Petroleum Company for the purchase of the Union Oil Company's properties, the enterprise will, of course, be appreciably greater. It has also developed that the interests back of the Weir syndicate are also controlling factors in the shipyards of Burmeister & Wain, who were the builders of the Diesel-motor ships *Selandia*, *Siam*, and many others; the East Asiatic Company; Harland & Wolf, who built the *Mauretania* and *Lusitania*; and the White Star line of Atlantic steamships. Due to the interest of Mr. Weir and his associates in the Diesel engine, it is regarded as easily within the bounds of possibility that Diesel engines of the type manufactured by Burmeister & Wain may be built in San Francisco. A plant with an annual capacity of 100,000 horse-power has been erected on the Clyde and it is stated that it will soon be doubled. It would appear that these large interests, in order to fortify their position in the commercial and financial world, have provided themselves with a fuel supply which, in combination with a large fleet of Diesel-motor vessels, should make them a potent factor in ocean freight carrying trade when the Panama canal is opened.

A FEELING of optimism has taken the place of the pessimistic attitude that has prevailed among oil men for the past six months. As about 90% of all the oil produced in California is of heavy grade and not suitable for refining purposes, a severe blow was dealt to practically all of the smaller producers when the Standard Oil Company several months ago gave notice that it would not purchase oil heavier than 18° Baumé. This resulted necessarily in a discontinuation of field operations to a large extent, the producers being compelled by reason of the lack of market to shut down their wells and wait for better conditions. Now it appears that buying of heavy oil has again commenced, while in the meantime the surplus in storage has been to a considerable extent depleted. A notable instance is the signing of a contract by the Standard Oil Company for the output of the Monte Cristo Oil Company's Kern River and Midway properties, as

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well as the latter company's large storage holdings of 14° Baumé oil. Many other purchases of heavy oil have followed. It is believed that better times are ahead for the oil producer and there is every indication of an increased consumption, and consequently better prices, in 1914.

THE passing of the dividend by the Union Oil Company may hardly be regarded in the light of a Christmas present to the shareholders. The announcement has been made by the directors, however, that dividend payments will be resumed in July, 1914, on the minimum basis of 4% per annum. The reason ascribed for passing the dividend is too much prosperity. At first thought this appears peculiar, but on the other hand a little thought will show why such a condition is possible. A greatly increased demand for the company's output, stated by Mr. Lyman Stewart to have doubled in four years, has resulted in a consequent increase of capital expenditure to provide facilities for meeting this demand. A large part of the funds to provide for these improvements has been obtained from earnings, the balance having been provided through the sale of bonds, debenture notes, and by floating indebtedness. The tightness in the money market, of course, necessitated extensive liquidation, making a further demand upon the earnings of the company. While the passing of the dividend doubtless entails a hardship upon the stockholders, it is believed that the ultimate results will be an improvement in the earning capacity of the company to a sufficient extent to compensate for the disappointment. That the Weir Syndicate will exercise the option held by the General Petroleum Company seems highly probable at this writing.

BY a decision recently handed down by the Supreme Court in what is known as the San Pedro tide lands case, it is held that since the adoption of the California State Constitution in 1879 no tide lands have been subject to sale by the State, and that the parties purchasing such property did so subject to the right of all to use the lands for commerce, navigation, and fisheries. The lands in dispute included some 1200 acres at San Pedro harbor and the decision states that the State never had any power to grant patents for this land, and that at any time the State decides that any of the tide lands are necessary for commerce or navigation, it has the power to take them away from the purchasers. It is held that actual title has been acquired only to lands lying back of an established harbor datum line, and which line has not only been established, but a sea-wall built and the property back of the sea-wall abandoned by the state as unnecessary to its commerce or navigation. The claimants in this case were the Southern Pacific Company, the Banning interests, and the Wilmington Transportation Company. The contention by the State, which contested the validity of the titles, were that tide lands cannot be sold by the State; that tide lands lying within two miles of an incorporated city cannot be sold; and that lands below the high tide mark and in navigable water cannot be sold. These contentions are upheld by the court, but existing wharf rights are not disturbed. The court also holds that the special act of 1872 incorporating the town of Wilmington put into operation the statutory reservation forbidding the sale of tide lands within two miles of an incorporated town, and that thereby all such land was withheld from sale until the repeal of the incorporating act of 1887.

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The San Francisco Water Supply Problem*

By C. E. GRUNSKY†

INTRODUCTORY REMARKS

THE San Francisco water problem has revolved about two focal points for the last twelve years. These two points are the acquisition of the properties of the Spring Valley Water Co. and the securing of rights, in part on the public domain, which will make possible the development of a large supply of water from the Tuolumne river. This last is a feature of what is popularly known as the Hetch-Hetchy project.

I may state at the outset, however, that the Hetch-Hetchy project of today differs materially from the Hetch-Hetchy project of ten or twelve years ago. The officers of the Commonwealth Club appreciating this fact, and the fact that the acquisition of the Spring Valley Water Co. properties has been making slow progress, have found it desirable to provide this opportunity for a review of the various phases of the water question. Some of our members who are conversant with the situation will, in so far as they feel at liberty to take us into their confidence, tell us of the water problem from various standpoints.

When, as City Engineer, I called attention to the availability of the Tuolumne river as a source of water-supply for San Francisco, and to the need of acquiring rights to store water in the Hetch-Hetchy valley and at Lake Eleanor, I was authorized to have surveys made that could be used as a basis for applications to the Secretary of the Interior for permission to store water in these two valleys.

Both Lake Eleanor and Hetch-Hetchy valley lie in a national forest reservation which was created by congressional action in 1890, and application for the rights-of-way required by San Francisco was made to the Secretary of the Interior under the law of February 15, 1901, which authorizes the granting of permits in the national forest reservation. The interpretation by Secretary Hitchcock of the powers and duties in the matter of granting rights-of-way through and over lands in national forest reservations, as conferred by this law upon the Secretary of the Interior, has proved unfortunate for San Francisco.

In 1902 the city, through Mayor Phelan, applied for a permit to use the Hetch-Hetchy valley as a reservoir site, also to use Lake Eleanor by raising its water surface. Nearly all of the level land in both of these valleys was already in private ownership; the lands in the public domain which it was desired to use, either for the erection of works or to be submerged, were lands of little value.

In the opinion of many who have given this matter thought, there was only one question before the Secretary of the Interior when this application for reservoir rights-of-way was presented.

*Address delivered before the Commonwealth Club, San Francisco, September 1913.
†American Engineering Corporation, San Francisco.

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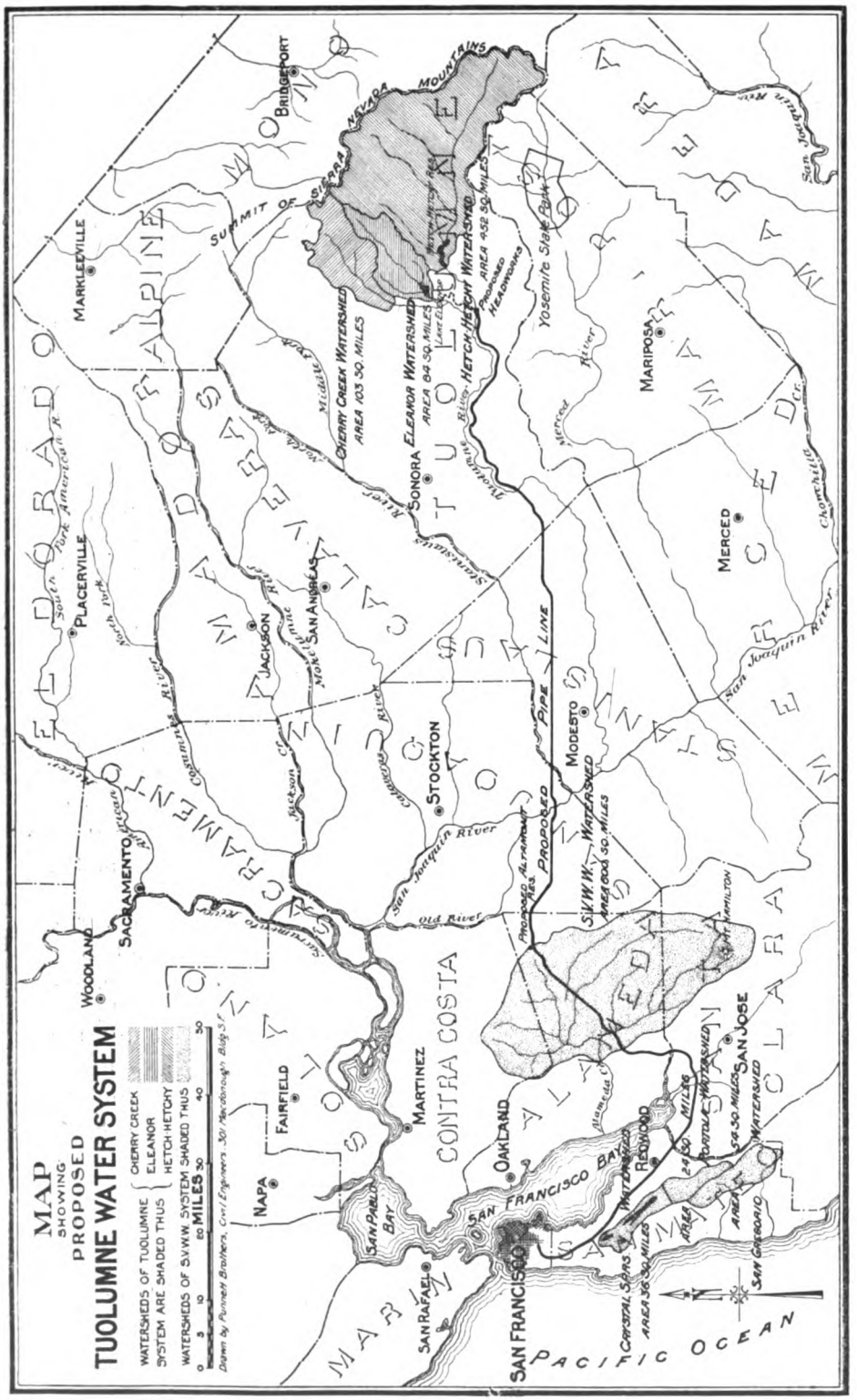

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The question to be determined was whether the Hetch-Hetchy valley or Lake Eleanor would ever be used as sites for the storage of water, or whether either or both of these valleys should be preserved for all time in their natural condition. In view of what we now know, this question having been fully and conclusively answered after ten years of controversy, the permit asked for should have been granted without any restrictions as to the city's rights to use the stored waters for the intended purpose.

Uncertainty in relation to this fundamental question may, however, explain the reluctance of the various Secretaries of the Interior to act favorably on San Francisco's application. In the case of both Lake Eleanor and the Hetch-Hetchy valley a permit was finally granted by Secretary Garfield in 1908, but with the proviso that Lake Eleanor water be first developed. The granting of this permit carried with it a recognition of the fact, by Secretary Garfield, that a permanent withdrawal of the Hetch-Hetchy valley from use as a reservoir would be subversive of the fundamental principle which should control such matters, because it would interfere with the conservation and use of a large part of the water flowing during the freshet season in the Tuolumne river.

The city had to submit to Secretary Hitchcock's denial of its applications early in 1903, and to a reiteration of this denial when, at a hearing on a review of the decision later in the same year, the city was opposed by the Spring Valley Water Co., by the Turlock and Modesto irrigation districts, and by various parties desiring to have at least the Hetch-Hetchy valley preserved for all time in its natural condition. The city was compelled, on the advice of the Secretary of the Interior, to make an appeal to Congress, an appeal which showed the city's determination to abandon no rights.

In the report of the Committee on Public Lands on the Raker bill, which report bears date of August 5, 1913, it is stated that the theory on which the bill granting certain rights in a national forest reservation to San Francisco is drawn, is that the United States has the right to impose certain conditions upon the grantee of rights-of-way in national parks. This statement is immediately followed by another that the bill is not drafted, nor designed, nor intended to usurp the powers of the State of California in the matter of control of the distribution of water. Notwithstanding this avowal, the bill in specific terms imposes conditions relating to the use and apportionment of the waters of the Tuolumne river.

It is self-evident that the city of San Francisco has at no time been in a position to deprive any community or individual of established rights. There never has been any question concerning the fact that the Turlock and Modesto irrigation districts had prior rights to Tuolumne river water and that these rights would in every way and at all times be respected by the city of San Francisco. Neither the Secretary of the Interior nor Congress should have made an agreement between the city of San Francisco and the irrigation districts a condition for favorable action on a right-of-way application. The moment that this is done there is exercised by federal authorities a control over the waters of the stream which the congressional committee is at some pains to disavow.

When the Tuolumne river was first selected as a possible source of water for the city, it was self-evident then as it is today that the city would have

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to respect established rights to water, and I may repeat what I have said on many occasions, that if the city had been allowed to proceed it would, upon completion of its reservoirs, not only have respected these rights, but it would have been in a position to give to the irrigation districts, free of charge, a large volume of stored water. The location of the two reservoirs in the watersheds of the Tuolumne river is unusually favorable. The run-off from large high mountain areas flows through them and both sites are favorable for the storage of water in quantity far in excess of the immediate needs of San Francisco. It will be many years, perhaps half a century, after these reservoirs are constructed before the requirements of the city will reach the supply that can be controlled with dams of moderate height. The excess water, of no use to San Francisco, can under suitable arrangements with the irrigation districts be liberated at such times as will result in greatest benefit to the districts.

Without attempting to express in figures the volume of water that could thus be made available for beneficial use in the districts, it is a patent fact that the construction of the two reservoirs will place San Francisco in position to render a valuable service to the irrigation districts.

The plan of dealing with the districts on the basis of delivering to them surplus stored waters is materially modified by the Raker bill. This bill will be discussed by others who are better informed than I am of its intent and of the obligations which the city will have to assume thereunder. I may be permitted, however, to point out that what San Francisco wanted when the applications for rights-of-way were first made was the use of a portion of the flood-waters of Tuolumne river and the privilege of storing it in the selected sites, with the intent incidentally to let the irrigation districts benefit by the surplus which would be under control until San Francisco's requirements have grown to the capacity of the works; and that, in contrast thereto, what the city gets under the Raker bill is that portion of the water stored in the reservoir sites which is left after the irrigation districts take not only the natural flow of the river up to the amount of 2350 cu. ft. per second, the amount of their prior filings, but also the natural flow for a 60-day period up to 4000 cu. ft. per second, or 75% more than these prior rights, and also the right to demand at cost the city's stored water to the limit of beneficial use by the districts.

In the matter of a water-supply for any large and growing city it is necessary to look far into the future. Half a century or more is only a short span of time in the life of a city. When large additions to a water-supply are to be made, this must be foreseen, and the necessary work must be undertaken long in advance of the actual requirements. Generally, three to five years are consumed in actual construction, and to have twice this time elapse from the inception of the project until definite conclusions are reached as to the source of supply and the character of the work is not unusual. In the case of the Hetch-Hetchy project, twelve years has already passed and we are not yet at the point where I had hoped we would be ten years ago.

In my official report, under date of July 28, 1902, which dealt with the Hetch-Hetchy project and was accompanied by general plans and a cost estimate for a complete water works of a capacity exceeding by 50% the present-day water consumption of San Francisco, I made the statement that

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the proper course for the city to take was to acquire the properties of the Spring Valley Water Co. and then to go to the Tuolumne for additional water. This statement was included in a report which under instructions from the Supervisors dealt with the Tuolumne river as an independent source of supply and which outlined a project entirely independent of the established water works. My conclusion that the city should at once acquire the properties of the Spring Valley Water Co. was not popular at that time, but gradually the soundness of the conclusion then reached has become apparent, and except for failure to overcome obstacles which have from time to time been raised, it has become the blazed trail on which we are still traveling.

The management of municipal water works must be taken out of politics. Ever since the city has voted bonds for a municipal system—$45,000,000 in 1909—the city has been in need of a Water Board. The city authorities were not, at that time, however, ready to let go. In consequence they found themselves embarrassed several years ago when they were called upon to defend the city's claim to rights in the Hetch-Hetchy valley and to show cause why the Garfield permit, in so far as the same related to the Hetch-Hetchy valley, should not be revoked. The preparation of the city's defense was finally turned over to an Eastern engineer who was called in because he alone seemed to be in a position to coördinate the work of investigation which was being carried on in several different city departments without a common head. It may be stated, too, that the investigations which were in progress and which were continued until the merits of all available sources of supply had received attention, had but little bearing upon the main question as to whether the Hetch-Hetchy valley would not necessarily some day have to be used for storage purposes in conserving and making available for use the large flow of Tuolumne river.

The investigations proceeded along the lines laid down by Mr. Ballinger, Secretary of the Interior, when he asked the city to show cause why the Garfield permit relating to the Hetch-Hetchy valley should not be revoked, and directed that special attention be given to the question as to whether Lake Eleanor and watersheds that could be made tributary to this lake, together with all other available sources of water, would not be adequate to supply the needs of San Francisco without recourse to water storage in the Hetch-Hetchy valley.

In addressing themselves to this question and to the methods of utilizing water from the Tuolumne river, the city authorities have allowed the project features, as presented to the Secretary of the Interior and to Congress in 1912 and 1913, to depart far from those which were originally contemplated and which were before the people when bonds were voted in 1909. It therefore seems likely that if the Raker bill becomes a law, there will have to be a re-submission of the water question to the electors.

As soon as the city acquires the rights-of-way in the national forest reservation which it has asked for, it will be necessary for the city to enter upon the construction of works, and definite project features must then be adopted. These may or may not conform to the scheme which the city has presented in the recent hearings at Washington. No final conclusion has been reached that the proper point to divert the water from the Tuolumne river is at the so-called Early intake above the mouth of Cherry creek, as referred to in the

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Raker bill. Neither has any final conclusion been reached as to the best conduit location, nor yet to the amount of water which should be brought to the city of San Francisco in the first unit of the conduit that will cross the San Joaquin and Santa Clara valleys. The scheme as submitted and explained to the Secretary of the Interior at the recent hearings has already been disavowed in some respects. The declared intention to use a large quantity of Tuolumne river water for the irrigation of lands contiguous to the bay of San Francisco, which greatly alarmed the residents of the two irrigation districts on the Tuolumne river and which may have been responsible in part for the aggressive demand made by the irrigation districts for water to which the city had prior rights, has been modified and under the terms of the Raker bill such use of any water diverted by San Francisco from the Tuolumne river will be prohibited.

Before the project is carried out there will be other modifications, and there will be problems of various kinds, such as rights-of-way over private lands, and all the various other matters related to a complicated project which should be handled by an efficient water board.

Moreover, there is better prospect now than ever before that the properties of the Spring Valley Water Co. will be purchased by the city, and in that event a water department must be established which should be free from the influence of partisan politics. Such a department would have been of great value to the city if at least the nucleus thereof had been created as soon as the city, in voting bonds, expressed its determination to acquire a municipal water works.

I may be permitted to repeat that Congress should not have been asked to prescribe or to decide upon the terms on which the flow of Tuolumne river is to be apportioned between a municipality and irrigation districts. It should have been sufficient for Congress to know that no vested rights would be invaded. The agreement which San Francisco makes with the irrigation districts has no bearing upon the one main question with which the federal authorities are concerned, as to whether the Hetch-Hetchy valley should or should not be used for water storage.

If the Raker bill be accepted as a precedent, Congress might as well authorize the Secretary of the Interior to at once assume complete control of all water originating in forest reservations and national parks whenever the utilization thereof involves a right-of-way over the public domain. Judged by this bill, there is apparently no limit to the conditions that can be imposed upon the user of water when such a right-of-way for its development is required. The spirit of the bill appears to be in conflict with the declaration in the last section of the bill, that nothing therein contained is intended to affect or in any way interfere with the laws of the state of California relating to the control, appropriation, use, or distribution of water.

In our own case the city, representing one-sixth of the population of the state of California, because it desires to use a small part of a forest reservation, must, among other things, if it accepts what is offered under the Raker bill, and in addition to the service which it is required to render to the irrigation districts:

1. Construct certain roads and trails in the Yosemite park at a cost of $500,000 to $1,000,000. The interest on this investment at 5% is $25,000 to $50,000 per year.

2. The city must maintain these roads and trails at a probable annual expend-

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iture of an additional $25,000 to $50,000 per year.

3. The city must make ten annual payments of $15,000 to the United States Government beginning five years after the passage of the bill, and thereafter for ten years it must pay $20,000 per year and then $30,000 per year. The present value of these payments at 5% is $330,000.

4. The city must make a large initial expenditure for storage, concerning which the Public Lands Committee of the House says "The city will expend from $500,000 to $1,000,000 in excess of initial expenditures necessary for its immediate needs," and explains that this is primarily a benefit for the irrigationists.

5. The city does not receive its requested rights of way free of charge. The city is required to transfer lands to the United States Government which have cost the city a large amount of money. The city, in other words, is required to pay for the land over which rights-of-way are granted.

Referring to some of the concessions which the city is to make to Turlock and Modesto irrigation districts to obtain the right to use Hetch-Hetchy valley, the Congressional Committee in its report says that the land owners of the irrigation districts "will receive the benefit of an investment of approximately $50,000,000 without being compelled to contribute any part of the cost, and the construction of the system will insure the priorities of the irrigationists and they will receive water in the dry period when it is most needed."

I have alluded to what the city will have to pay in addition to amounts already expended for rights on the Tuolumne river, others will tell what the city needs and what it will get under the Raker bill and when it acquires the properties of the Spring Valley Water Company.

The present daily water consumption in San Francisco from Spring Valley Water Co. sources is about 40,000,000 gallons.

W. R. Scowden in 1874, in a report to the supervisors of the city, recommended Calaveras creek as an adequate source of supply. The reservoir site on that creek and other sources of water in the Alameda creek system were subsequently acquired by the Spring Valley Water Company.

Colonel G. H. Mendell, on behalf of the city, in 1875 and 1876, made a comprehensive study of the available sources of water and submitted a report which is of great value.

Ever since the new charter went into effect in January 1900 the city has been endeavoring to acquire a municipally owned system of water works.

In 1901 application was made for the city by Mayor James D. Phelan for reservoir sites at Lake Eleanor and in the Hetch-Hetchy valley, both situated in the watershed of Tuolumne river. These applications were denied in 1903 by Secretary of the Interior Hitchcock. They were granted with certain restrictions by Secretary Garfield in 1908.

In 1909, by a vote of about 33,000 for to 1600 against, a bond issue was authorized for a Tuolumne river project and at the same election, by a vote of 22,068 to 11,722 the purchase of the Spring Valley Water Co. properties at $35,000,000 was defeated. A two-thirds vote was necessary to carry this proposition.

In 1910, Secretary of the Interior Ballinger required San Francisco to show cause why the Hetch-Hetchy valley should not be eliminated from the Garfield permit; and an Advisory Board of Army Engineers was appointed to pass upon facts submitted.

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In February 1913 the Advisory Board of Army Engineers filed its report, which was favorable to the contention of San Francisco that it should be granted the permit applied for.

Secretary of the Interior Fisher, upon submission of the report of the Army Engineers, advised that the whole matter be referred to Congress for action.

Secretary of the Interior Lane shortly after taking office concurred in this view.

The matter being further considered at Washington by representatives of San Francisco and by representatives of Turlock and Modesto Irrigation districts, a bill was framed granting certain rights on the Tuolumne river to San Francisco, and this bill, introduced by Congressman Raker, was passed by the House and is now before the Senate.

In the matter of the purchase of the properties of the Spring Valley Water Co. but little progress has been made since 1909. The city authorities have failed to agree with the water company upon a purchase price, and after long negotiations it has now been agreed to have a value determined by judicial procedure.

The water rates established by the Supervisors in 1902 and subsequent years have not been satisfactory to the water company. The matter was taken into court and resulted in a decision by Judge Farrington fixing a value of the properties in use for supplying the city with water and declaring the rate ordinances which were complained of void. The moneys collected by the water company in excess of the rates fixed by the Supervisors since 1902 are being deposited in bank subject to the order of the court. The water company has not been content with any rates fixed since 1902 and the matter of adequate rates is still in the courts.

At present, after a second season of light rainfall, there is a shortage of water in a number of California cities and towns and the amount of water in the reservoirs from which the city obtains one-half of its supply is low.

Present Status of the Hetch-Hetchy Water-Supply Project*

By M. M. O'SHAUGHNESSY†

AT a dinner at Washington tendered by James D. Phelan last June to various people from California and Government officials, Secretary Bryan asked what Hetch-Hetchy meant, whether it was a new war dance or an Indian dance, and judging from the activities and the amount of oratory that has been expended on the project for the past twelve years, his inquiry seems to have been justified.

My connection with the project commenced the first of last September, a year ago, when I was appointed city engineer, succeeding Marsden Manson. At that time there was under presentation by the city to Walter Fisher, Secretary of the Interior, reasons why San Francisco should get possession of the Hetch-Hetchy valley and not be

*Address before the Commonwealth Club, San Francisco, September 1913.
†City Engineer, San Francisco.

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excluded from it, as suggested by Secretary Ballinger. At the same time, there was an Army board of three engineer officers appointed, Colonels Biddle, Cosby, and Taylor, who had been working on this and the various alternative projects for very nearly a year or a year and a half. In their employ was Mr. Wadsworth, their assistant engineer, who traversed all the water propositions in California possible as alternative sources for a water-supply for San Francisco. This board last February filed a report with the Secretary of the Interior giving their conclusions and all their analyses of the situation and of the different propositions. They practically rejected all the different alternative water schemes and selected Hetch-Hetchy as being the most available. In summarizing for you their analyses and conclusions, which are very carefully thought out, and dispassionate, I cannot possibly do better than recite to you part of the report, especially as regards the all-important proposition of our relations with the irrigationists. Every other antagonist and visible opponent of the city's plans has possibly been eliminated except the irrigationists, and here are the conclusions of this Board, on pages 34, 35, and 36 of their report filed February 19, 1913, on that subject.

"Legitimate and proper use of water in the reasonable development of irrigation districts tributary to or which can be made tributary to, the Tuolumne river.—The irrigable land between the Merced and Tuolumne rivers and between the Tuolumne and the Stanislaus will be first considered, excepting Oakdale district, now irrigated from the Stanislaus river. The area of the existing Turlock-Modesto district is 402 square miles. The Board estimates that 60% additional could well be added thereto, making a total of 643 square miles. In a recent map issued by the United States Department of Agriculture, in coöperation with the Conservation Commission of California, the total area of irrigable land in this region is given as about 690 miles. Therefore, 643 square miles of land actually to be irrigated within probable districts would seem liberal. It is not claimed, however, that all possible irrigable land is included in this map. There may be, especially in the foothills, additional land to which water might well be applied.

"Based on water being actually supplied to 85% of the 643 square miles (or 411,520 acres), a duty of 2½ ft. and losses of 23%, the quantity of water needed is estimated by the Board at 1,132,000 acre-feet per year.

"The Turlock-Modesto district claims to need for its present district alone 1,042,043 acre-feet. This is stated to be based on 90% of 402 square miles, a duty of 2.75 ft. with losses of 39%. These figures are considered extreme and those stated by the Board would seem ample."

Now, instead of the 411,000 acres for which the Board of Army Engineers says there is water available as well as the supply of 400,000,000 gallons per day for San Francisco, the acreage limited in the Raker bill is exactly 300,000 acres, or 111,000 acres less than the Army Board says there was enough water for.

Their final conclusions on this subject were:

"The determination of the amount of water flowing in the Tuolumne has been mainly deduced from records at the La Grange dam, the point of diversion for the Turlock-Modesto district. This was gauged from 1878 to 1884 by the State of California, and by the United States Geological Survey from 1895 to date. Rainfall records at La Grange date from 1878. There are few records for the upper watersheds. The upper Tuolumne has been gauged by the city for only three years. As this is such a short period, the results obtained by applying to other years the same proportion of run-off for upper and low watersheds as is indicated by the three-year record cannot be considered conclusive. At the same time, this is all the direct evidence available. In order to assist further in the estimation of this important result, the records of the upper and lower Stanislaus, from 1905 to date, have been used for comparison. These rec-

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ords are necessarily incomplete, and therefore to that extent unsatisfactory, but would seem sufficient to arrive at general conclusions. On the calculations made from these records, it is estimated that with a storage of 750,000 acre-feet, the necessary 400,000,000 gallons per day can be taken to San Francisco, while usually giving the full reasonable requirements of 640 square miles of the irrigation district. Of this 750,000 acre-feet storage, about 560,000 acre-feet would be necessary for the city to obtain 400,000,000 gallons per day and the remainder for irrigation. Some years the water supply for irrigation would have been short, as for example in 1898, 40%; in 1908, 14%; and in 1912, 14%. With a storage capacity of 900,000 acre-feet there would have been sufficient water for irrigation except in 1898. For the latter year a storage capacity of 1,400,000 acre-feet would have been required and would be practically impossible to obtain economically."

Some years the number of acre-feet run-off each year measured at La Grange from the Tuolumne watershed is down to 850,000 acre-feet. Other years the annual run-off is over 3,000,000 acre-feet; and the general average for the 21 or 22 years measured run-off from this watershed is 2,080,000 acre-feet. The time has come here in California, with the enhanced value of our lands, when all available water will have to be conserved in practicable reservoirs in the mountains and foothills. Those districts have been rather slow in conservation of storage water. During their entire ten years of life they have only stored 168,000 acre-feet. Realizing the importance of changing this policy, they are now spending considerable money in building additional storage reservoirs, and it is not very difficult for them to find very desirable additional ones, which will command their lands at a lower level. Immediately south of Turlock, between the Tuolumne and Merced rivers on Dry creek, is one storage reservoir with a capacity of 350,000 acre-feet, from which flood-waters from both Tuolumne and the Merced rivers may be led by relatively short canals.

One of the most pressing claims by the irrigation districts of Turlock and Modesto, presented at Washington, was their right to share in the use of the Hetch-Hetchy reservoir site. During many preliminary discussions of this question in past years by the Board of Supervisors and city officers, the city felt disposed to be friendly with the irrigationists, and the present city administration desires to be exactly fair with them. On the other hand, the irrigationists have not been returning kindness for our efforts in that direction, as witness the statement from the Turlock Board of Trade of April 28, 1913: "San Francisco obtained the Garfield grant of reservoir privileges for 40,000,000 gallons of water daily. The districts relied on San Francisco's sincerity and had sufficient faith to believe that it would never ask for more water than 40,000,000 gallons per day. But apparently San Francisco considered this merely as an entering wedge, for in 1909 the question of the Garfield grant was reopened and resubmitted. In the short space of four years San Francisco now asks and demands from the Government, instead of 40,000,000 gallons of water daily, 400,000,000 gallons daily, or ten times as much. What reason have the districts to believe that the city will not ask a hundred times as much in another four years?"

During the discussion at the hearing at Washington before the House committee, some of the irrigationists communicated there as follows: "Hon. Scott Ferris, Chairman Public Land Committee, care of L. L. Dennis, Ebbitt House, Washington, D. C.: God gave San Francisco the Pacific Ocean, the rest of the world to the Standard Oil Co., but the waters of the Tuo-

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lumne river belong to Stanislaus county.''

During the past eight or twelve months there has been a very insidious campaign conducted all through the San Joaquin valley promulgated ostensibly for the needs of the farmers; but the real 'niggers in the woodpile,' some of the power companies, have not shown their heads except occasionally. Mr. Hatton, the attorney of the Yosemite Power Co.—Mr. Hammond's company —presided at a meeting at Modesto of indignant farmers. So, besides the nature lovers and the real thinking farmers, we have also this hidden and insidious enemy that has been steadily fighting the wishes of the city.

Your representatives in Washington did the very best they could, from an equitable standpoint, in making arrangements with the Turlock and Modesto irrigation districts. After our hearing from November 25 to 30, 1912, which lasted six days, before Secretary of the Interior Fisher, and in which about 1200 pages of testimony was taken, the members of our delegation, after returning to San Francisco and considering the demands of the irrigation district, made a proposition to them in a revised proposal to sell all surplus waters not needed by the city for about $2 per acre-foot, which would be about the actual cost of storage. The irrigationists, on resuming the discussion of matters before the House committee, rejected that proposal and said they did not know whether the water was worth $2 per foot or $1 per acre-foot; they would pay exactly what the water cost; and one of the conditions in this Raker bill is that they do not get any stored water free; what storage water they get they pay the total cost of impounding, including the cost of the land, dam structures, engineering, and all the other incidental costs necessary to impound water. The Turlock and Modesto districts and their representatives feel that they have been fairly treated by the representatives of San Francisco. Some of their people and constituents do not feel so. They think that they have been injured by this agreement.

Now, besides the organized irrigation districts which have established rights on that river, not one drop of whose water in the flowing stream, which they are using, have we a right to take, there are a lot of 'mushroom' districts recently organized, one of them being the Waterford district, the creation of my friend, Judge Dennett, to make further demands on the city of San Francisco; and your representatives in Washington had to decline to give consideration of any kind to the demands of those gentlemen.

Having completed five water systems successfully from the first scratching of dirt to the completion of each project, I feel safe in saying that with the completion of the Hetch-Hetchy dam and the Eleanor dam there will be enough water for San Francisco—400,000,000 gallons per day, over seven times the size of Mr. Grunsky's original project, and also for the irrigationists down below when they complete economic reservoirs in and near their lands.

In reply to a criticism made by Mr. Grunsky as to the rates of payment to the Government: for the first five years the Government gets no payment; after that we pay them $15,000 a year for 10 years; after that $20,000 a year for 10 years; and permanently thereafter we pay them $30,000 a year. That is 5% interest on $600,000; or $30,000 a year is what we pay annually to the Government for the right to go and submerge the lands in those two reservoir basins,

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various rights-of-way, and the right to develop power along the route. Considering that the city's present investment in lands for a portion of those rights aggregates $1,400,000 or $70,000 a year, the Government charge, while onerous, is not unreasonable, as the proceeds go to improve the Yosemite National Park, San Francisco's and California's outing region.

Now, the present project as outlined by Mr. Freeman differs very materially from the original proposition outlined by Mr. Grunsky in 1902. His proposition called for 60 million gallons of water per day with an ultimate capacity of 160,000,000 gallons per day; no power was generated along the route except enough to lift the water over the Altamont pass.

Mr. Manson, at a later date, in 1908, made a revised proposal, very similar to that of Mr. Grunsky's, with power a minor asset.

Mr. Freeman, after giving this project a year and a half of study, and as an engineer who has been identified with the largest water construction works in the United States and the world, after viewing the conditions of all the bay cities, broadened this proposition and raised the capacity of the project to an ultimate of 400,000,000 gallons per day. On the route laid out by him are two falls, one of about 1200 ft. and the other 1400 ft., from which over 150,000 hp. will be developed. This power has been valued by various people at from $20,000,000 to $40,000,000 as an asset in the project. True, instead of bringing his line on the surface by open ditch, as recommended by Mr. Grunsky, he bores through the mountains and brings his water in tunnels, which is a much safer way to bring water than through surface ditches, subject to slides, falling trees, and falling rocks. Personally, I have had experience with several projects owned by San Francisco people who have retained me to construct water projects in Hawaii, and they built all their conduits in tunnels and were not afraid of the cost of tunneling; and the wisdom of this type of construction has been well demonstrated by immunity from accidents and damages and consequent interruption of service; and since those works have been built, some of them ten years ago, they have not been one day out of commission.

The city engineers have been so very busy fighting all the antagonistic systems that enough thought has not been given to all the phases of Mr. Freeman's project; and before the city embarks in construction, it will be very well to have every feature of this scheme very carefully criticized by a dispassionate board of at least three experienced construction engineers with no prejudices on the subject.

The attitude of the departments in Washington has materially changed with the advent of Franklin K. Lane to the portfolio of the Secretary of the Interior. During last November your representative got the cold shoulder from Secretary Fisher, who, after putting us to all the expense of spending nearly a quarter of a million dollars in preparing and presenting this project, ignored the recommendation of his own Board of Army Engineers and put it into the waste-basket the day before he left his office. Mr. Lane has assumed a different attitude; and if it were not for Mr. Lane this proposition would not be advanced where it is today in Washington.

There have been various criticisms by so-called experts as to the wisdom of the arrangement made by the city, and that we have given away all the city's rights, and in order to get the absolute facts as to the amount of water in this

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watershed and the amount of it available for San Francisco, I have had the hydraulic engineer in my office, Mr. Bartell, who is a very conscientious and scrupulous man, make an unbiased examination of this proposition, and here is his analysis:

San Francisco, California,
August 4, 1913.

Mr. M. M. O'Shaughnessy,
City Engineer,
San Francisco, California.

Dear Sir—There is herewith transmitted an analysis of the uses of the waters of the Tuolumne river, California, in accordance with the provisions of the 'Raker Bill,' a copy of which is herewith attached. In this analysis, the following conditions have been assumed:

	Acre-feet.	
San Francisco storage.....		689,700
Irrigation storage:		
(a) Foothill 168,000		
(b) Storage above the La Grange dam but not within the San Francisco drainage area..308,000		
Total irrigation storage..		476,000
Grand total storage.....		1,165,700

Based on the above storage, the analysis has been made for the period during which stream flow measurements have been made at La Grange, viz., September 1895 to date.

A study of the tabulation sheets reveals the following:

1. During the entire period, there is no time during which the irrigation needs require more than their allowance of 2350 second-feet, that is, during the past 17 seasons, in order to satisfy the full irrigation requirements, it was not necessary for the irrigationists at any time to take advantage of their right to draw up to 4000 second-feet during the period April 15 to June 13, inclusive.

2. At no time during the past 17 seasons was it necessary to draw on San Francisco storage to satisfy irrigation requirements.

3. It will also be noted that during the high flow period of every season, the irrigation storage is completely filled and that the San Francisco storage is completely refilled during every season except 1897-1898, when there was in storage at the end of May 1898, 619,417 acre-feet, about 90% of the total storage.

The maximum depletion of the irrigation storage comes in October 1898, when there is left in storage 152,645 acre-feet. At the end of this same critical period, February 1899, there is left in San Francisco storage 317,212 acre-feet, and in June 1899 San Francisco storage is again completely filled.

During the present season, 1912-13, irrigation storage reached its lowest point in October 1912, when there was left in storage 213,100 acre-feet and it was completely filled at the end of May 1913. For the same reason, San Francisco storage reached its lowest point in April 1913, when there was left in storage 316,540 acre-feet, and at the end of June 1913 there is left in storage 521,210 acre-feet.

The minimum amount left in San Francisco storage during the past 17 seasons, as above noted, was 316,540 acre-feet at the end of April 1913.

Around the San Francisco bay, in reservoir sites already developed and proposed, there can be economically made available 144,000,000,000 gallons or 440,000 acre-feet. This, together with the 316,540 acre-feet (left in storage at the end of the most critical period investigated) leaves San Francisco and the bay cities with enough storage on hand to supply its needs of over 500,000,000 gallons per day, for about 15 months, without the catchment of a single drop of water.

A tabulation has been made showing the amounts of water in acre-feet in excess of 2350 second-feet and less than 4000 second-feet of the natural daily flow of the Tuolumne river.

M. J. Bartell.

Some of the peculiar attitudes developed by statesmen in Washington have been shown by one of our senators in California, Senator Works. On August 8, 1913, Senator Works wrote a letter here to San Francisco and said the principal reason for opposition to the Hetch-Hetchy bill was that San Francisco was not getting enough, the irrigationists were getting too much. The other day he said he had complaints from 99% of the irrigationists that San Francisco was going to rob

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them. So much for the consistency of one of our senators from California. But we are very glad that we did not have to rely upon this California senator to carry this measure through in Washington. We have had very good friends in the East, many of whom came to our hearings prejudiced from reading the deceitful propaganda published against us; but after listening to our representations and seeing the earnestness of our purpose to be fair to everybody, they came over to our side, and some of the best friends we have now for San Francisco are those who live east of the Mississippi river.

Comparison of the Garfield Grant and the Raker Bill*

By MARSDEN MANSON†

A COMPARISON of the rights the city now holds under the Garfield grant and those alleged to be granted by the Raker bill can best be understood by a review of the rights and properties now held with the rights to be 'granted' by the pending bill and the conditions of the properties now owned under letters patent should the terms of this bill be accepted by the citizens of this city.

Under the Garfield grant and subsequent acquisitions and rights, the city owns:

1. The right to develop Lake Eleanor, a reservoir about 900 ft. higher than Hetch-Hetchy and having a greater capacity with a 250-ft. dam than Hetch-Hetchy with a 300-ft. dam. The Lake Eleanor dam under the Garfield grant is considerably cheaper than Hetch-Hetchy with a smaller dam and the expensive conditions attached to the 'grant' under the Raker bill.

2. The right to develop Cherry Valley reservoir and several minor reservoirs, all at a greater elevation than Hetch-Hetchy and of greater potential per unit of stored water for power.

3. The right to develop Hetch-Hetchy whenever it shall be required. This, however, has been revoked by Secretary Lane, for the purpose, I understand, of giving right-of-way to the Raker bill. Why that should be done I have not been advised. As the Raker bill is to 'supersede' the Garfield grant if the people accept the terms of this bill, I do not see why any one portion of it (the Garfield grant) should be revoked to make that right-of-way clear.

In each of these reservoirs San Francisco holds under letters patent all of the previously privately held land in those reservoirs.

4. The right-of-way for a canal diverting the waters of Cherry creek into the Lake Eleanor reservoir.

5. The right-of-way for a diverting canal of the combined waters of Cherry Creek drainage and Lake Eleanor drainage from the west line of the park to the North Mountain power station.

6. A power site embracing the diver-

*Address before the Commonwealth Club, San Francisco, September 1913.
†Consulting Engineer, San Francisco.

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sion works and head-gates at North Mountain power station.

7. A diverting dam and canal right-of-way from the westerly line of the park on and along the left bank of Tuolumne river to the above-named power station.

8. A right-of-way for a canal from the North Mountain power station through and over the public lands of the Stanislaus national forest reserve from the North Mountain power station to the South Fork, with a power site at this point for utilizing the low-water flow of the drainage basins above the North Mountain power station, liberating this excess of low-water flow for districts below.

9. The right-of-way from the South Fork power station to the westerly line of the Stanislaus national forest reserve. Also all the necessary state rights and filings required for the full development and utilization of the storage and water-power rights above named.

10. Perpetual use of 10 acres of land near Lake Eleanor reservoir in the Stanislaus forest reserve.

11. Perpetual use of 76 acres of land for a power and maintenance station at the junction of the South and Main Forks of Tuolumne river.

Upon these properties, and in the purchase of over 3000 acres of land, the city has expended over a million dollars, of which $13,728 was to the United States government, thus fixing a financial as well as a legal and moral obligation to maintain the integrity of the Garfield grant.

That grant was attacked by Secretary Ballinger after he had stated that he would not disturb the decision of his predecessor. He, however, got back to Washington and manifestly certain pressure was brought to bear upon him by our friends very properly named by Mr. O'Shaughnessy 'the power company'—probably others—but these interests were manifestly the principal source of that pressure. Mr. Ballinger cited the city to show cause why its right to ultimately develop the Hetch-Hetchy as given under the Garfield permit, when needed, should not be revoked. The imposition of that delay on the original project outlined by Mr. Grunsky of the utilization of Hetch-Hetchy first, was due to an unfortunate promise made by Mr. Roosevelt to our esteemed friend John Muir that he, Mr. Roosevelt, would not permit the Hetch-Hetchy valley to be 'desecrated' by using it for the highest purpose for which it could be used, in Mr. Muir's lifetime. In trying to secure the Garfield grant I found that promise an insuperable wall. Realizing the possibility of utilizing Lake Eleanor and the necessities that this city was under, and knowing, too, that we owned seven-elevenths of the floor of the Hetch-Hetchy, and that we would get a greater electrical potential out of the waters of Lake Eleanor, at greater elevation, we simply had to accept the terms of this promise. It was submitted to the people of the city by a unanimous vote of the Board of Supervisors, and approved, in spite of a very earnest and persistent opposition, by a popular vote of over seven to one.

San Francisco thus holds, under the Garfield grant, all the rights and titles necessary to develop the ultimate possibilities of a superb water-supply unencumbered by any obligation impairing the use and ownership of the water, or imposing payments to the Government far greater than have ever been exacted from private corporations and for the first time in the case of a municipality.

Now, it is not a question in my opinion in comparing these grants, or

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rather, I should say the Garfield grant, with what must be characterized as the Raker bill 'hold-up', because it does nothing for this city but hold it up, from the water itself down to the measuring apparatus for the districts themselves; this city has to pay for everything, nothing is granted. San Francisco thus conditionally holds under that law the waste flood-water that is stored under state acquirement. It belongs, as provided under the laws and constitution of this state, to the people who pay for storing the waste flood or extra seasonal water; and it is not a question that we have to decide. It has also been very ably decided by successive boards of engineers, from the time the United States government officials undertook this investigation in 1897 down to today, that there is an abundance of water. The real question is whether San Francisco shall pay every cent of the cost of development and storage and be the benefactor of the irrigation districts, the Government of the United States, and the 'nature lovers', and whether the stored water and developed waters shall belong to those who pay for it, or, through the terms of this bill, to some one else.

In that connection we have the statement reported in the *Congressional Record* (Vol. 50, pp. 4526-4527) by Mr. Church: "Mr. Chairman and gentlemen of the committee: I have heard it frequently mentioned during the progress of this debate that the city and county of San Francisco will be the beneficiary under this act. I rise to say that San Francisco will not be its only beneficiary, for they are numerous. Every traveler in the future who visits the Hetch-Hetchy valley will be a beneficiary under this act, for if this bill passes, travelers, instead of riding mules, horses, or crawling on hands and knees up and down the narrow, rugged, and devious pathway that leads backward to this place of beauty in the heart of the mountains, can travel in an automobile over the broad and ample road provided according to the provisions of this bill.

"And the nature lover, it matters not from what land he comes, in my judgment will be one of its beneficiaries, for after exerting all his strength and reaching at last the mountain top and looking for the first time downward into Hetch-Hetchy, instead of beholding it as it now is, brushy, and covered with an inferior growth of oak, will see a lake, blue, beautiful, and deep, in which fishes swim and on the borders of which campers rest, far away from civilization and the humdrum of active life.

"And farmers far down at the base of the mountains on the San Joaquin plains will be beneficiaries under this act when they draw from this contemplated reservoir, held by a dam, which the millions of others have made, surplus water at cost with which to irrigate their farms.

"And other beneficiaries there will be who pump water with which to irrigate their vines, orchards, and alfalfa fields, pumped by electric power generated far back in the mountains, in power-houses not their own, brought to their very gateways at cost, on copper wires they did not swing.

"And the great city of San Francisco, Queen City of the West, situated by the Golden Gate, will be the chief beneficiary, but I love to consider its benefit more from the standpoint of the people than I do the city, for a million men, women, and children will be there receiving benefits from this bill, for in the summer time they will have cool refreshing water, product of Sierra's winter snow, pure as earth affords, with which to slake their thirst.

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and those there using electric power, whether it be the city operating electric car lines or the washerwoman using her electric iron, each and all will be benefited by this act."

But who pays for all these benefits? Why should "the great city of San Francisco, Queen City of the West," be required to pay to benefit anything or anybody, when, under the laws, it has appropriated those waters, owns in fee the greater portion of each reservoir, and owns all necessary rights? I thought that we were at the end of our expenses, so far as hold-ups were concerned, when we paid $168,000 for the Smith lands in the Hetch-Hetchy valley; Canyon Ranch, the homestead and Tiltil valley; and when we paid to John Hays Hammond and his associates $1,054,000 for the lands and rights in Lake Eleanor, Cherry valley, and adjacent thereto, which they had bought and secured title to. I find that in addition we are now, under this bill, not only required to pay this impoverished Government of ours for building a million dollars' worth of roads, the interest on another million in their maintenance, 5% interest on $600,000 for rights-of-way, but on top of that we are subjected to a condition which is in my opinion the most outrageous and tyrannical attempted on the people of the United States since 1765, when the Stamp Act was imposed (par. n, sec. 9, of the Raker bill).

There is in this bill a clause which prescribes that, in case we do not develop this water and power in the manner prescribed in this bill, the Secretary of the Interior can deprive this city, not only of the rights and powers alleged to be conferred thereby, but of the works constructed thereunder and of the properties acquired, and lease the same to some person or persons. How on the face of the earth a provision of this sort was permitted to get into this bill is beyond my comprehension.

Next, Mr. Grunsky referred to the conflicting statements with regard to what this bill purports to do with the water, which, if I understand the history of water distribution and water measurements and water acquisitions, has been repeatedly sustained as belonging to the state. Mr. Mann, of Illinois, characterized the trouble that Mr. Grunsky pointed out in very strong, exact, and clean-cut language. On page 4525 of volume 50 of the *Congressional Record* you will find that he says that: "The gentlemen on the Committee on Public Lands themselves, divided in sentiment and opinion as they are upon this subject, have executed the most skillful straddle that I have ever seen in the way of a bill. It is impossible upon reading this bill to determine what the opinion of the Committee was. In one portion they assume that the laws of the state of California shall regulate the appropriation and distribution of water. In another they assume that Congress, by imposing conditions upon that distribution, has the right to apportion the water." It is to be regretted that the gentlemen did not forecast the litigation which this bill will surely inaugurate.

In Mr. Bartell's analysis, presented by Mr. O'Shaughnessy, is given the total available storage. Much of that storage, if I understand the situation correctly, is in the South and Middle Forks of the Tuolumne river and Poopenaut valley, a reservoir held by the companies owned by one John Hays Hammond and his associates. Is San Francisco, to carry out the terms of this bill, to be again compelled to buy these out? These districts are, however, restricted in their storage under this bill to a cost of $15 per acre of stored water.

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They cannot store much of the waste water under any such restriction. If it were a question of their storing their own water, nobody in the world would raise any objection; the only points of great merit are, shall San Francisco store water for the districts, or shall the districts store it for themselves? Shall San Francisco be held up by Congress for the benefit of the districts, the Government, and the 'nature lovers'? It is bad enough to be held up for our rights-of-way and give up all rights thereunder in case we find it inconvenient or impossible to use them at the rates here prescribed. Another Secretary of the Interior can turn around and say to San Francisco: "You have not fully and satisfactorily to me developed the rights conferred by this bill, consequently not only the privileges you have acquired by virtue of this, but also the properties acquired otherwise, shall be forfeited—structures, lands, rights, and machinery—anything that you have acquired from any source in this connection, whether prior to or subsequent to this bill, shall be forfeited, *to be leased to some person or persons that he may select.*" (Sec. 9, par. n, Raker bill.)

I hope you will take this bill and read it critically; study every line of it. It is one on which the future of this city very largely depends, and whether we shall be called on to pay for everything down to the measuring apparatus for the districts themselves. They do not pay anything, they only accept; nature lovers do not pay anything, they only accept; all is for San Francisco to pay, with very serious doubts as to the ownership and division of the stored water, and an addition of 75% to the liberated water during the productive period, April 15 to June 15, of each year!

One thing I will say, that I feel, as a former member of the Sierra Club, somewhat in sympathy, though I regret to say it, with that club. They undertook to prevent the use of the Hetch-Hetchy valley. It was not to be used under the Garfield grant, in all likelihood within the lifetime of any member of that club, and if they could have seen the result that under this bill the Hetch-Hetchy was to be used at once, I believe that they would have gotten down on their knees and begged Ballinger or Fisher or anybody to let the Garfield permit alone.

Anticlinal Dome Structure in California Oilfields*

By DORSEY HAGER†

IT IS not uncommon to find that doming of formations is higher in certain directions than in others. On one anticline that comes to mind, four domes are known, as shown in Fig 1a. The elevation of the oil formation of the western dome should be approximately 250 ft., at the next 600 ft., at the third 1000 ft., and at the last 1500 ft. above sea-level. A cross-sec-

*Further notes presented as a continuation of an article that appeared in the issue for September 1913.

†Geological Engineer, Title Insurance Bdg., Los Angeles.

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tion along the anticlinal axis would probably appear as in Fig. 1b. In the case above, the oil in I, II, and III would be under the water and the gas pressure of IV. Again, it might be thought that all the oil would migrate from I, II, and III to IV. This has not proved true, however, as dome III has proved productive.

Domes I and II have not yet been prospected with the drill. The results should, however, prove interesting and

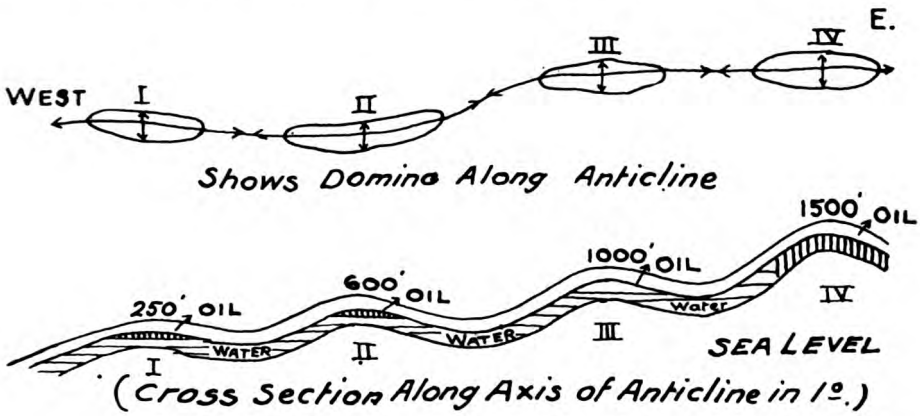

FIG. 1. ANTICLINE HAVING FOUR DOMES.

valuable to operators. These domes will probably prove productive immediately at their apices. Drilling short distances away from the apices will result in water trouble.

Drainage Area.—It is interesting to study the relative size of domes, though thus far very little detailed information as to the longevity and the productivity of certain domes has been worked out. Domes vary greatly in size. The drainage area of a dome is measured from depression to depression along the anticline, and from syncline to syncline. The true shape of most drainage areas is elliptical. The lengths and breadths of domes vary greatly. One known dome is 11 miles long and 6 miles wide. Others are 7 by 2, 3 by 2, and 5 by 2 miles, respectively. A few comparative areas cited from actual field work are 80, 30, 10, 6, 5, and 4 square miles. One can see how small some domes are known to be and how large others.

The Montebello dome, which has proved so productive, has a drainage area approximately 3 miles long and 3 miles wide, or 9 square miles in all. Flattened out, this would be considerably greater, 10 square miles not being too large an estimate. The South Mountain dome, which has a drainage area of 80 square miles, may in time prove a greater producer than the Montebello property, though no one can safely predict that such will be the case, as local conditions may greatly modify the productivity of a dome. Studies at the Eastern and of the Santa Susana mountains show the domes there much smaller than farther west. Three domes in line gives areas of 6, 4, and 5 square miles respectively.

Such estimates as the above are very instructive. As one can see from Fig. 1b, domes, though on the same anticline but lower in elevation, will not in all likelihood be as productive as those relatively higher in elevation.

Then, too, the material from which petroleum was derived may be richer

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in certain localities than in others. As yet, data are too meagre for anyone to draw accurate conclusions as to the relative productivity of anticlinal domes, but the subject would be of much economic value, were sufficient data at hand with which to work out all the questions involved.

The notes presented above especially show the value of more careful studies of productive regions.

Cause of Doming.—The two theories advanced[1] before to explain the cause of doming may both be correct; field evidence especially bears out the cross-anticlinal theory. However, another theory fully as plausible appeals to me, especially where no evidence of cross-anticlines exist.

Folding seems undoubtedly due to the shrinkage of the earth's crust which results in a crinkled condition of the earth's surface. The shrinkage can be resolved into two sets of forces of unequal values acting at right angles to each other. Thus, shrinkage can be said to follow two principal directions at right angles to each other. Where folding occurs in a given direction there will be a simultaneous shrinkage at right angles to the main direction of folding, which would, in all likelihood, cause doming along the axis of the main structure.

Los Angeles Harbor Improvements*

By CHARLES T. HUTCHINSON

HARBOR improvements now under way for the port of Los Angeles at San Pedro are being carried on through funds provided by two bond issues. The first of these is the residue from an issue of $100,000, voted by the city of Wilmington prior to its annexation by Los Angeles, and the second an issue of $3,000,000 voted in 1910. The status of the funds on August 31, 1913, was as follows:

Total to be expended on Inner Harbor		$1,000,000
Total expended	$652,079.96	
Estimated liability	220,266.84	
Estimated cost of proposed improvements.	53,944.00	
Available balance	73,709.20	
Total		$1,000,000

Total to be expended on Outer Harbor		$2,000,000
Total expended	$1,126,353.26	
Estimated liability	626,643.79	
Available balance	247,002.95	
Total		$2,000,000

On April 15, 1913, an additional bond issue of $2,500,000 was voted, but the condition of the bond market has been such that no satisfactory offer has thus far been received. The attention of the Harbor Board has therefore been concentrated upon the completion of the various projects at present planned in order that the harbor may be in condition to obtain a share of the expected influx of ocean traffic when the Panama canal is open to commerce.

[1] *Western Engineering*, September 1913.

*Taken in part from report dated July 1, 1913, by S. A. Jubb, Harbor Engineer, a further progress report dated September 1, 1913, and the annual report of the Los Angeles Harbor Commission, July 1, 1913.

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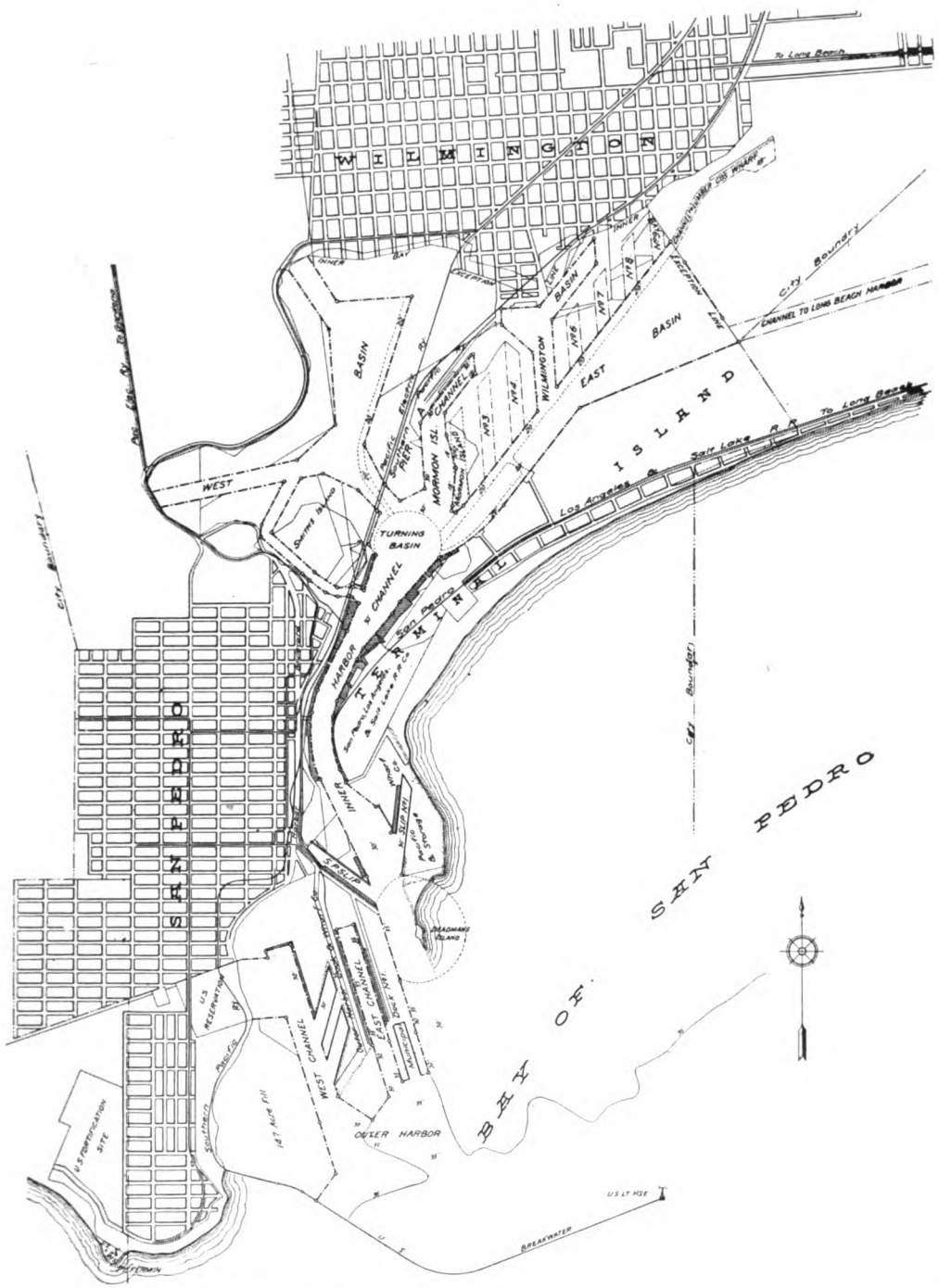

MAP OF LOS ANGELES HARBOR AT SAN PEDRO, CALIFORNIA.

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The following summary of work under way in connection with the accompanying map will serve to show the present status of the entire project.

IMPROVING WILMINGTON AND SAN PEDRO ROAD LOT L

	Quantities.	Rogers Bros. Co.		Bent & Pennebaker.		Occidental Construction Co.	
Excavation, yd.....	3,600	$0.40	$1440	$0.34	$1224	$0.30	$1080
Paving, sq. ft.....	27,000	0.09	2430	0.10	2700	0.135	3645
Shoulders, sq. ft....	11,000	0.037	407	0.045	495	0.045	495
Culvert, lin. ft.....	158	2.50	395	2.00	316	1.50	237
			$4672		$4735		$5457

CREOSOTED PILING FOR WATER-STREET WHARF

Creosoted piles.	Quantity.	Con. Lumber Co.		St. Helens Creo. Co.		Puget Sound Wood Pres. Co.	
26 ft. long	31	$17.42	$ 540.02	$14.69	$ 455.39	$16.64	$ 515.84
28	30	18.76	562.80	15.82	474.60	17.92	537.60
30	57	20.10	1,145.70	16.95	966.15	19.20	1,094.40
32	24	21.44	514.56	18.08	433.92	20.48	491.52
34	29	22.78	660.62	19.21	557.09	21.76	631.04
36	26	24.12	627.12	20.34	528.84	23.04	599.04
38	28	25.46	712.88	21.47	601.16	24.32	680.96
40	37	26.80	991.60	22.60	836.20	25.60	947.20
42	35	28.14	984.90	23.73	830.55	26.88	940.80
44	46	29.48	1,356.08	24.86	1,143.56	28.16	1,295.36
46	37	30.82	1,140.34	25.99	961.63	29.44	1,089.28
48	49	32.16	1,575.84	28.08	1,375.92	30.72	1,505.28
50	56	33.50	1,876.00	29.25	1,638.00	32.00	1,792.00
52	67	34.84	2,334.28	30.42	2,038.14	32.28	2,229.76
54	47	36.18	1,700.46	31.59	1,484.73	34.56	1,624.32
58	93	38.86	3,613.98	33.93	3,155.49	37.12	3,452.16
Sheet piling	88.664 M	46.00	4,078.54	43.00	3,812.55	48.00	4,255.87
Total			$24,415.72		$21,293.92		$23,682.43

ROCK RIP-RAP FOR WATER-STREET WHARF

		Russell-Greene-Foell Co.		Standard American Dredging Co.	
Furnish and place under wharf..	4700 tons	$2.20	$10,340	$2.35	$11,045
Furnish and place on cars on wharf	4700 tons	1.80	8,460	....	.....

INNER HARBOR

Wilmington and San Pedro Road.—This section of street work through lot L includes 1150 lineal feet of oil macadam road from the east line of Vermont avenue to the easterly line of lot K. The Rogers Bros. Co. were the contractors, and the cost, 9c. per square foot, giving a total of $4672. This work was about 65%, completed on September 1. Unit bids are shown on the schedule following:

Water Street Wharf and Fries St. Bulkhead.—This work is being carried on by force account and is well under way. The specifications call for a wood wharf 50 by 670 ft. on creosoted piles. The bulkhead consists of 400 lin. ft. of creosoted pile behind which is a 2000-yd. sand back-fill and is protected against wave action by 6000 tons of

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rip rap. In all, 692 piles were driven and 88,700 ft. B.M. of lumber was required. The estimated total cost of this work is $48,500.

Dredging Slips No. 1 and 5 and Filling Lands Adjoining.—This work involves the removal of 650,000 yd. of material from each slip and depositing it upon lands adjoining. The Standard American Dredging Co. is the contractor for this work at prices of 13¼ and 14c. These slips are in Wilmington basin and Mormon Island channel and will have a depth of 30 ft. when the work is completed. An extension has been made to this work, covering the removal of 300,000 yd. in the east basin from Wilmington basin to the turning basin, at a price of 14c. per yard, which includes bulkheads. This channel will have a bottom width of about 150 ft. and a depth of 30 ft. below mean low water.

WATER STREET WHARF BEFORE BACK FILLING.

Bulkheads, Pier A.—This work in-

SHED NO. 1, PIER A

	Shed complete.	Shed without 38 doors.	38 Cross folding doors.	38 doors as submitted.
Willard-Slater Co.	$83,000	$76,000	$7,000	.....
Dutro Wren Construction Co.	63,948	60,438	7,703	$8,740*
Snare & Triest	68,979	60,239	8,000	.....
Mercereau Bridge & Construction Co.	84,790	75,790	9,000	8,750*
Alta Planing Mill Co.	55,829	48,178	.....	13,650†

*Wilson steel.
†Kinnear steel.

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volves the construction of 3000 lin. ft. of creosoted bulkheads along the east and north side of pier A, and driving 90 foundation piles for shed No. 1. The creosoted construction is being done by the Pacific Creosoting Co. and the general construction by the Mercereau Bridge & Construction Co. The total cost will be $23,071.97.

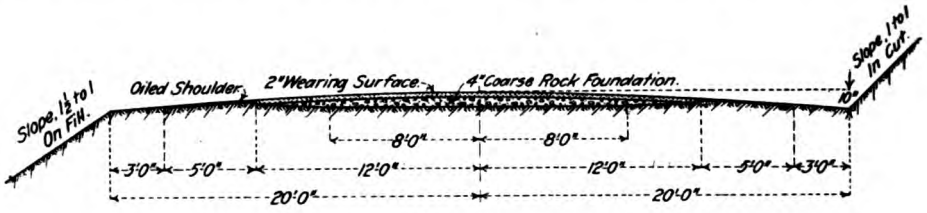
Pier A, Shed No. 1.—This is a wood frame transit shed 100 by 600 ft., with asbestos protected metal sides and roof. Drains, sewers, foundations, and 38 doors on the water side are required.

The electric wiring installation has been undertaken by the Southern California Electric Co. at a price of $2023. Contract for the sprinkler system has not been let.

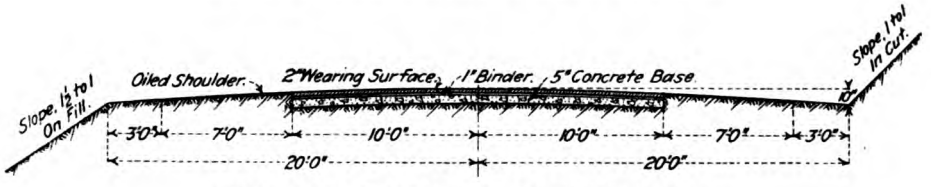
Wilmington basin has been dredged to 25 ft. below datum line, and Fries street filled with this material to a point about 13 ft. above harbor datum. The contract price was 24½c. per yard, making a total of $2525.22. A similar section of this work, known as Wilmington fill No. 1, included dredging Wilmington basin and Mormon Island channel to 20, 25, and 30 ft. deep and filling 100 acres to an average height of 7 ft. The unit prices were 21½ and 24½c. per yard and amounted in all to $265,274.70.

J Street Improvement.—About two miles of grading and oil macadamizing was done from Reyes road to West First street. The contract price was 7.1c. per square foot, totaling $24,824.21.

Wilmington and San Pedro road through lot K was improved for a distance of about 600 ft. The contract for oil macadam was 10c. per square foot, totaling $3340.49. The method employed for constructing oil macadam roads is as follows: After the road has been brought to the prescribed grade and cross-section, the surface is plowed to a depth of 4 in. This is followed by a thorough breaking up by a cultivator followed by a harrow. Then the surface is dampened and rolled with a 10-ton roller. Next, the first stone course is laid. This consists of broken stone of which 95% will pass a 3-in. ring and remain on a 1½-in. ring. The second course of broken rock to pass a 1½-in. ring and remain on a ¾-in. ring is then applied. The surface coat consists of rock broken to pass through a ¾-in. ring. The whole road is then sprinkled with water and allowed to stand four



TYPICAL ROAD CROSS-SECTION FOR MACADAM BASE.



TYPICAL ROAD CROSS-SECTION FOR CONCRETE BASE.

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hours before the oil is applied. The oil is applied at a temperature between 235 and 375°F. A coat of screenings that will pass through a 4-mesh screen and remain on a 14-mesh screen is then applied. After an interval of 12 hours, first oil and then screenings are again applied, after which the entire surface is thoroughly rolled until smooth, with a 6-ton tandem roller. The total oil used must not exceed 1½ gal. per square yard. Thirty days after, the road surface is again given an oil coat of 0.2 gal. per square yard, sprinkled with screenings, and again rolled. The oil contains not less than 85% asphaltum.

Fries Street Sewers.—Storm and sanitary sewers were built along Fries street from Bryant street to Wilmington basin at a cost of $7300.

STORM AND SANITARY SEWER IN FRIES STREET

	Storm.	Sanitary.
B. C. Nichols and P. S. Tourich	$6500.00	$2500.00
John Sutalo	5672.00	3936.00
John Balch	8000.00	2774.00
L. A. Bridge & Const. Co.	5500.00	1800.00
W. N. Hendricks	8300.00	2150.00
M. N. Pekich	5750.00	2850.00
W. F. Hewitt Co.	7144.88	4150.85

A portion of the street work is being carried on under the Vrooman Act. Canal street from Seventh street south to First street is being paved with asphalt on a cement concrete base. For this work $13,468.36 has been expended up to July 1, and it was contemplated to extend this work to the water front upon completion of the fill now under way. Pacific avenue and Fourteenth street are also to be improved in the same manner, and $62,000 has been set aside for this work.

Mormon Island Channel Wharf Pier A.—This is a wood wharf, 50 by 1600 ft., on creosoted piles and has been completed at a total cost of $103,340.45. Schedule of several bids covering the wharf construction proper is as follows:

MORMON ISLAND CHANNEL WHARF

	Quantities.	Russell-Greene-Foell.		T. G. Shea.		Mercereau Bridge & Construction Co.		Munoz & Munoz.	
		Rates.	Amount.	Rates.	Amount.	Rates.	Amount.	Rates.	Amount.
Wharf complete, with railroad	600 ft.	$22.50	$13,500.00	$30.60	$18,360.00	$23.40	$14,040.00	$21.21	$12,726.00
Wharf complete, without railroad	1005 ft.	18.71	18,803.55	26.70	26,833.50	19.10	19,195.50	18.03	18,120.15
Sheet piling in place	174 M ft. B.M.	45.35	7,890.90	58.20	10,126.80	43.40	7,551.60	61.61	10,720.14
Rip-rap	10,000 tons.	1.50	15,000.00	1.85	18,500.00	1.75	17,500.00	1.39	13,900.00
Shell and sand fill	5,000 tons.	0.50	2,500.00	0.30	1,500.00	0.30	1,500.00	0.54	2,700.00
Wing walls	Comp.	....	300.00	....	1,583.00	....	781.50	....	1,382.00
Railroad	Comp.	....	2,000.00	....	2,418.00	....	1,831.40	....	1,616.00
Total		....	$59,994.45	....	$79,321.30	....	$62,400.00	....	61,164.29

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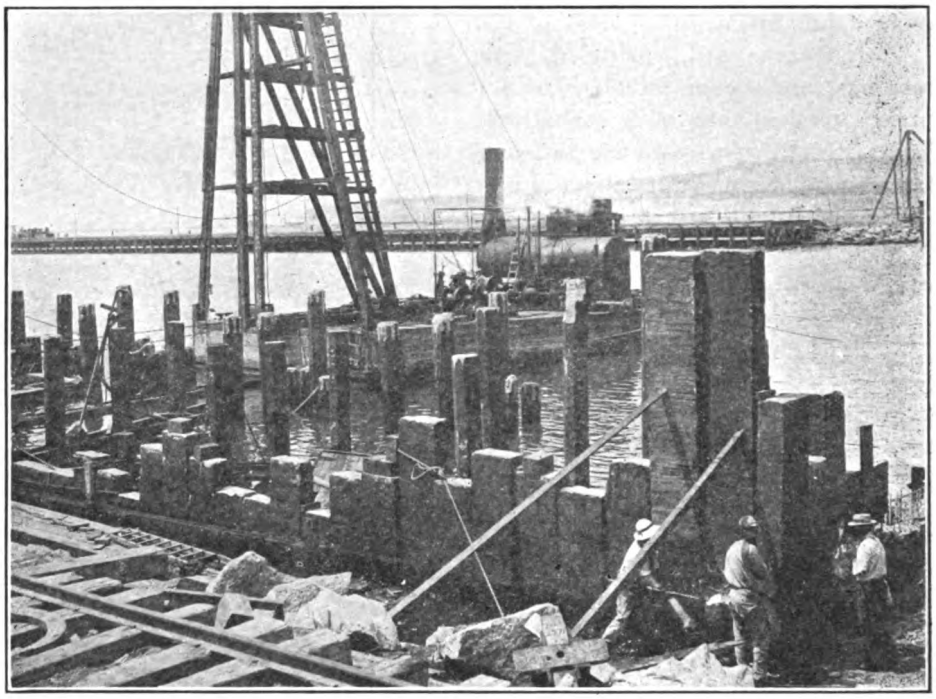
Water Street Wharf Shed.—Plans have been completed for a one-story shed, 100 by 510 ft., with wood frame and asbestos protected metal covering. The estimated cost complete with electric light and sprinkler systems is $63,500.

OUTER HARBOR

Municipal Dock No. 1.—The Standard American Dredging Co. has the contract for filling area B, about 60 acres, to an elevation of 12 ft. above the harbor datum with material taken from area A, giving a depth of 35 ft. below the datum line. Dikes are being constructed to retain the fill in area B and protected by rip-rapping. The material handled is sand and some shale, totaling about 1,400,000 cu. yd. at 14.48c., the unit cost of the dikes $1.33 per yard, with $0.145 added per ton for 12,500 tons of rip-rap in place.

Dredging Area C.—This work is being done by the Standard American Dredging Co. and calls for dredging a channel 35 ft. deep along the east side of Municipal Dock No. 1. In all, 475,000 yd. of material is to be removed at 20c. per yard, and also a portion of the west jetty. The latter calls for the removal of 8000 yd. of rock at 50c. and 9000 yd. of rock at 70c. and placing it on Huntington fill dike.



DRIVING CONCRETE SHEET PILING WITH STEAM HAMMER.

Miscellaneous.—Various minor improvements are under way, including a landing at First street, a spur track, including 750 tons of 75-lb. rail with splice bars, bolts, and spikes furnished by the U. S. Steel Products Co. at a cost of $30,853.90, and 16,000 6 by 8-in. by 8-ft. ties furnished by the E. K. Wood Lumber Co. at a cost of $8576.

New Work.—Plans and specifications are completed for the steel frame for Municipal Dock Shed No. 1. Plans and

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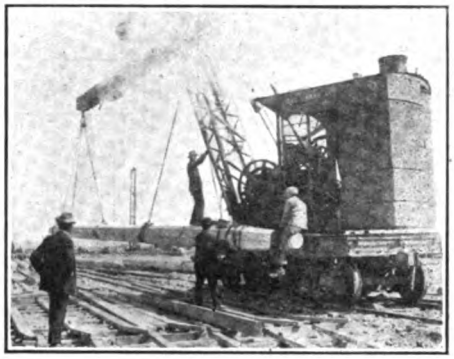
cross-sections for the Harbor boulevard are also ready. Fisherman's wharf, Fries street improvement, and Water Street Wharf shed are also ready.

The structure known as the Outer Harbor wharf is by far the most elaborate piece of work that has yet been undertaken for Los Angeles harbor. The contractors are Snare & Triest of Los Angeles, and the work in general includes the construction of about 2520 lin. ft. of reinforced concrete wharf 40 ft. wide, including 580 ft. of railroad track, sheet pile bulkhead, anchorage, rip-rap protection, and concrete pile foundation along the westerly side of Huntington fill. Unit bids on this work are shown below:

Steel cylinder piers were originally planned for the wharf supporting mem-



BROWN HOIST HANDLING CONCRETE PILES.

bers, but upon reconsideration a substitution was made of a cluster of five 18

Item.	Quantity.	Snare & Triest. Price.	Russell-Greene-Foell. Price.	Somers & Lund. Price.
a. Steel in cylinders, per lb	1,222,000	$0.044	$0.053	$0.055
b. Reinforcing steel and anchor rods, with connections, per lb	1,600,000	0.04	0.04	0.038
c. 18-in. concrete bearing piles, complete, per lin. ft.	14,280	1.85	2.10	2.12
d. 16-in. concrete bearing piles, complete, per lin. ft.	17,320	1.60	2.05	2.07
e. Concrete sheet piles, complete, per lin. ft.	30,500	2.05	2.00	2.35
f. Class 'A' concrete (except in piles), per cu. yd.	80	14.00	10.00	17.00
g. Class 'B' concrete, per cu. yd	5,160	13.00	9.50	13.65
h. Class 'C' concrete, per cu. yd	3,650	6.70	7.00	7.20
i. An additional price per cu. yd. of concrete if crushed stone is used	.....	0.40	0.50	1.00
j. New rip-rap, per ton	26,000	1.30	1.40	1.90
k. Shifting rip-rap from present dike, per cu. yd.	6,000	1.00	1.10	1.55
l. Dry wall, per cu. yd	105	5.00	4.00	7.00
m. Special fill back of sheet piling:				
1st. Rip-rap per ton	24,000	1.30	1.40	1.70
2nd. Spalls, per ton	24,000	1.20	1.10	1.55
3rd. Shell fill, per cu. yd	24,300	0.70	0.60	0.55
n. Untreated piles in cylinders, per lin. ft.	17,500	0.44	0.60	0.52
o. All other untreated piles, per lin. ft	60,800	0.33	0.40	0.31
p. Asphalt pavement, per sq. ft., including base	100,000	0.19	0.16	0.20
q. A lump sum for all other work called for in these plans and specifications	.....	13,600	8,000	43,195
r. Rip-rap	.....	458,967	466,470	555,263
s. Spalls	.....	456,567	459,270	551,663
t. Shell fill	.....	444,777	447,450	527,828

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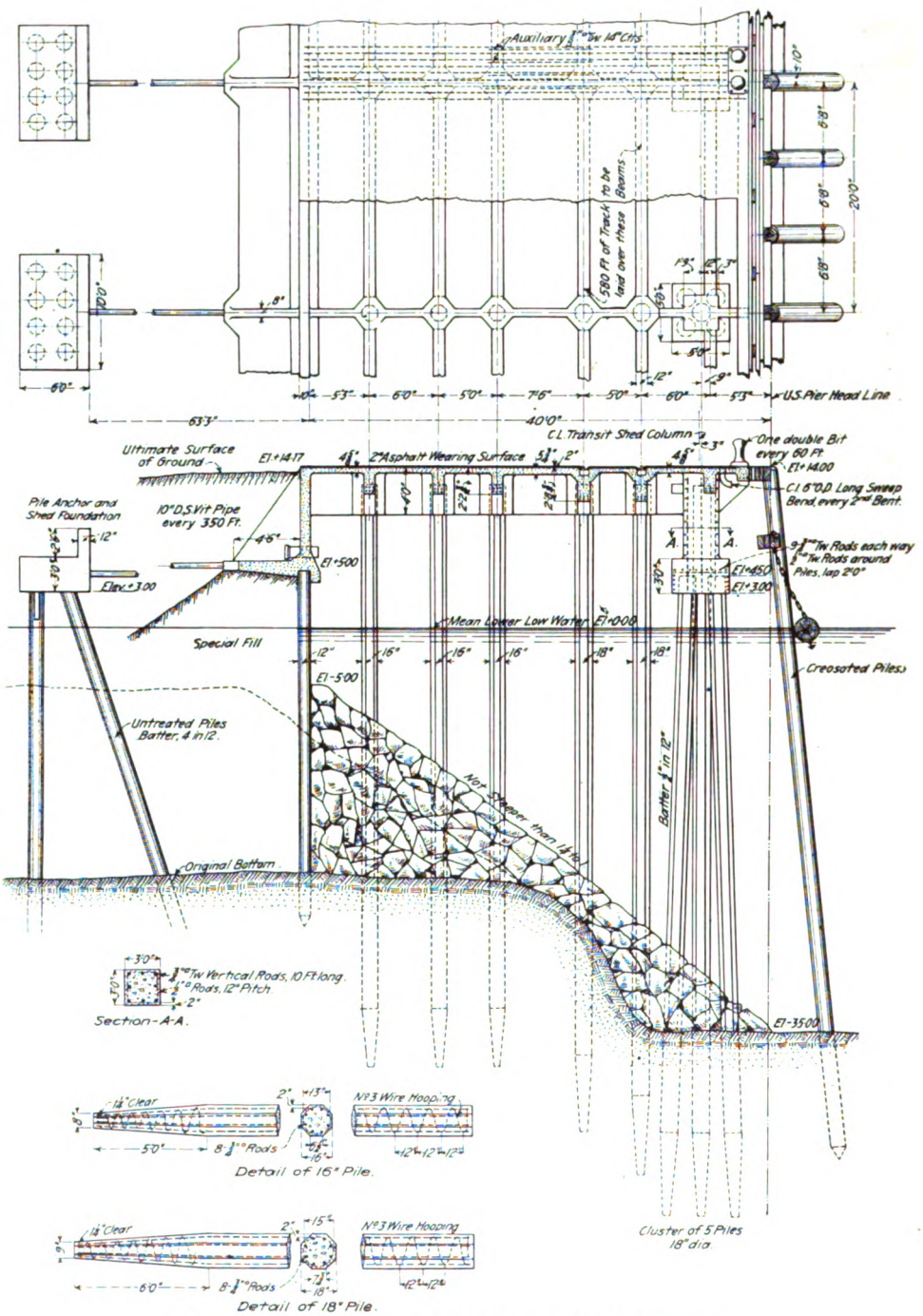
Auxiliary
580 Ft. of Track to be laid over these Beams
U.S. Pier Head Line
C.L. Transit Shed Column
Ultimate Surface of Ground
Asphalt Wearing Surface
One double Bit every 60 Ft.
C.I. 6" O.D. Long Sweep Bend, every 2nd Bent.
Pile Anchor and Shed Foundation
10" O.S. Vit Pipe every 350 Ft.
Mean Lower Low Water
Special Fill
Creosoted Piles
Untreated Piles Batter, 4 in 12.
Batter 1 in 12"
Not Steeper than 1½ to 1
Original Bottom
Section - A-A.
Detail of 16" Pile.
Detail of 18" Pile.
Cluster of 5 Piles 18" dia.

SIDE ELEVATION AND DETAILS OF OUTER HARBOR WHARF.

in. diam. reinforced concrete piles in their stead. This change, together with the elimination of a 6-in. concrete paving base and the cluster of wood piles, provided for the column foundation for the proposed two-story transit shed

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and the adoption of a revised fender system resulted in a saving of about $20,000 and a construction at least as good as the one first proposed.

In drawing up the specifications for the cement some innovations were introduced that in the light of the results achieved may hardly be regarded as improvement over standard specifications. The specifications called for a cement to comply with the following requirements: "The ratio (2.8 times percentage of SiO_2 + 1.1 times percentage of Al_2O_3 + 0.7 times percentage of Fe_2O_3) divided by (percentage of CaO + 1.4 times percentage of MgO) must be greater than or equal to 1. The quantity of magnesia (MgO) shall not exceed 3%. The cement shall not contain more than 1.5% of anhydrous sulphuric acid (SO_3). The following sieve tests were also prescribed: 92% to pass 100 mesh and 85% to pass 200 mesh. For tensile strength it was specified that after 24 hours exposure in moist air the briquettes should show 150 lb.; after 7 days, 1 day in moist air and 6 days in water, 450 lb.; at 28 days, 1 day in moist air, 27 days in water, 550 lb. The briquettes made of 1 part cement and 3 parts standard testing sand were required to show tensile strength as follows:

At 7 days (1 day in moist air, 6 days in water), 150 pounds.

At 28 days (1 day in moist air, 27 days in water), 225 pounds.

Cement tested at 28 days and not showing a 20% increase in strength over the 7-day test was to be rejected. In addition, the cement was required to stand the so-called 'Autoclave' boiling test. The Autoclave test requires that neat cement briquettes 1 in. square in section shall be made as specified above and shall be kept in moist air for a period of 24 hours. The briquettes shall then be placed in an Autoclave and well covered with water. Steam pressure shall then be raised to 285 lb. per square inch, within a period not exceeding 45 minutes. Steam pressure shall then be maintained for 1 hour and 15 minutes. The Autoclave shall then be blown off and the briquettes removed and as soon as cool shall be broken in a standard testing machine. These briquettes, to satisfactorily pass the requirements, must remain firm and hard, must show no signs of expansion or distortion, checking, cracking, or disintegrating, and must have a tensile strength at least equal to that of briquettes made from the same sample of cement kept in moist air for a period of 24 hours and then broken.

It will be noted that the magnesia content demanded was 1% lower than the standard specification of the American Society for Testing Materials and that the percentage of cement required to pass a 200-mesh screen was 10% greater than the minimum prescribed by standard specifications. As the hardening of cement is a chemical process, its relative activity is measured by the superficial area of the particles. The large increase in the degree of fineness specified therefore could not fail to result in a much more rapid setting cement that would attain the greater part of its strength at the end of the 7-day period and show comparatively little, if any, increase by the end of the 28-day period. A well balanced cement, ground so that 85% will pass a 200-mesh screen, shows a tensile strength of 750 lb. at the end of 7 days and 780 to 800 lb. at the end of 28 days. Such a cement, although showing tensile strength far in excess of the requirements, would be rejected for not giving the 20% increase specified between the 7 and 28-day periods.

It is difficult to understand the logic of specifications so contradictory in

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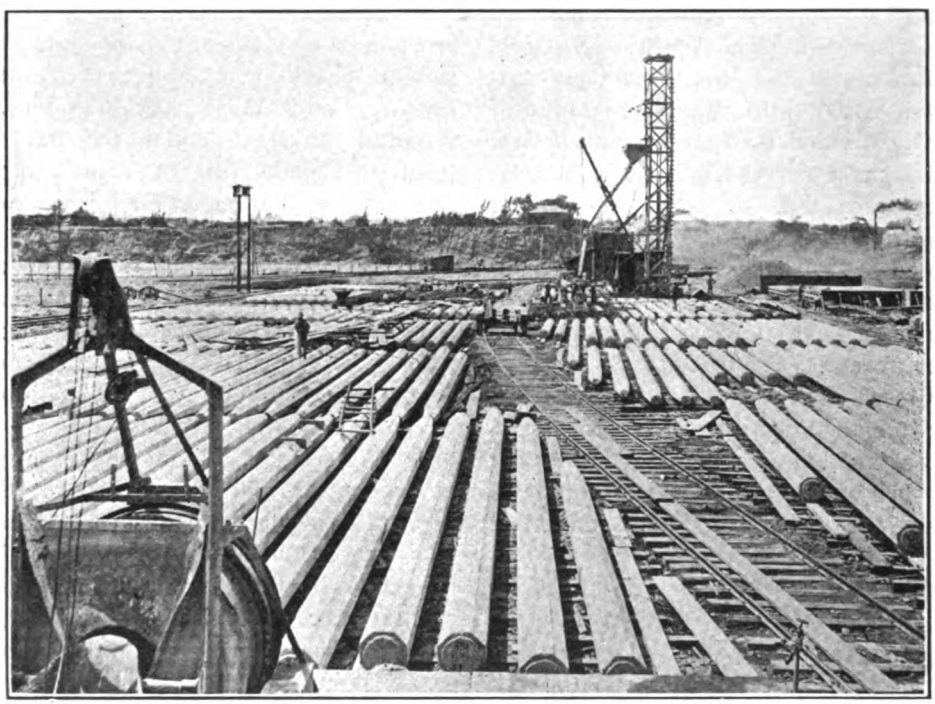
their provisions. The Autoclave test is a revival of an old rather than a new method. Dykerhoff and Erdmenger, in the early eighties, proposed this test for determining the constancy of volume of cements high in magnesia. The German Association of Portland Cement Manufacturers and the Royal Testing Laboratory at Charlottenburg, after a long and exhaustive series of experiments, abandoned this test as utterly useless for the purpose.

At the 1913 meeting of the American Society for Testing Materials, this test was extensively discussed. Allerton Cushman brought out the significant fact that in the Autoclave test, reactions take place which are far removed in their nature from the actual hardening process of portland cement under normal conditions. He laid particular stress on the silica-lime reactions. It is well known that in the manufacture of sand-lime brick, properly sized sand is mixed with sufficient quantity of hydrated lime and pressed into bricks. These bricks are then subjected to high steam pressure for a number of hours, during which the silica and lime combine chemically and bond the aggregate. It would appear from this that an over-clayed cement would readily pass the Autoclave test and could probably meet the minimum requirements for tensile strength laid down in the harbor specifications.



STORAGE YARD FOR CONCRETE PILES USED FOR OUTER HARBOR WHARF.

The failure of the reinforced concrete piles as first made for the Outer Harbor wharf again calls attention to the specifications. The concrete was specified to consist of 1 part portland cement, 1½ parts sand, and 3 parts crushed rock or screened gravel. To this dense mixture was to be added water-proofing to

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the amount of 2% of the volume of cement. This water-proofing is a pasty substance consisting essentially of stearate of magnesia coagulated by aluminum sulphate. Here is presented the curious anomaly of a specification for cement demanding a product low in alumina and magnesia, and then using a water-proofing compound adding 2% of these same constituents that have an admittedly deleterious effect upon the strength of the concrete. In the manufacture of the piles, plain reinforcing bars were used and piles costing about $15,000 were constructed. After curing for about 40 days, an attempt to raise the piles resulted in their breaking, the fractures occurring on the tension side. The area of the concrete above the neutral axis in compression showed no sign of failure, indicating that the reinforcing bars had slipped. Accordingly, the contractor had constructed test pieces 6 by 6 in. by 6 ft. long, using ¾-in. bars imbedded in concrete with and without the water-proofing compound. After being allowed to set for a week, the steel imbedded in the water-proofed concrete could be twisted loose with an ordinary pipe wrench. On the other hand, the steel imbedded in the unwater-proofed concrete was firmly set in place and attempts to loosen it by twisting only resulted in twisting the reinforcing bars. The harbor authorities brought these matters to the attention of E. P. Goodrich, the consulting engineer who drew the specifications, and he replied in effect that he did not have sufficient data to warrant him to authorize the omission of the water-proofing compound. The harbor engineers, however, assumed the authority and the piles were duplicated without the water-proofing. The contractor was paid the sum of $12,934.85 for his work, which was the full amount of his contract less the cost of driving.

The Gem, Idaho, Irrigation District

By CARL GEORGE de LAVAL*

SUNDAY, May 4, 1913, saw the culmination of the efforts of the Gem irrigation district when the Crane Falls Power & Irrigation Co., Ltd., turned into the canals on the 30,000-acre tract the long desired water from the Snake river.

The earliest method of water pumping used in this territory was by a paddle wheel with buckets attached. This style of pumping is still used on many small farms along the lines of various canals in the Boise valley wherever water velocity is sufficient and the elevation of the land to be watered is suitable. The wheel is limited in its capacity, and, picturesque as it may be, it still affords but a weak weapon in the fight against drouth and sterility.

In the two pumping stations for the Gem district are installed nine electric motor driven pumps in four batteries. Three pumps lift water to an elevation of 175 ft.; two lift water to an elevation of 100 ft., and two lift water 60 ft. In the smaller station, the two pumps lift the water 104 ft. When all

*Chief Engineer, Henry R. Worthington, Harrison, New Jersey.

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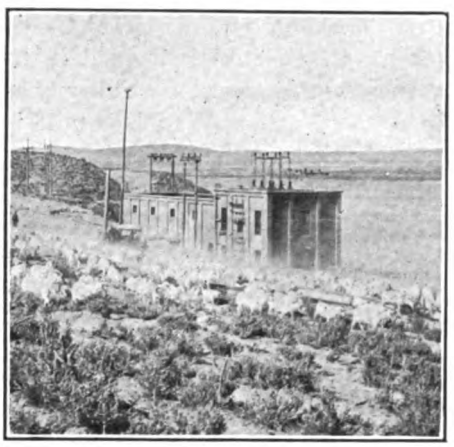
of these pumps are in operation they will absorb 5685 hp., equivalent to the output of the largest water-power electric generating stations in this part of

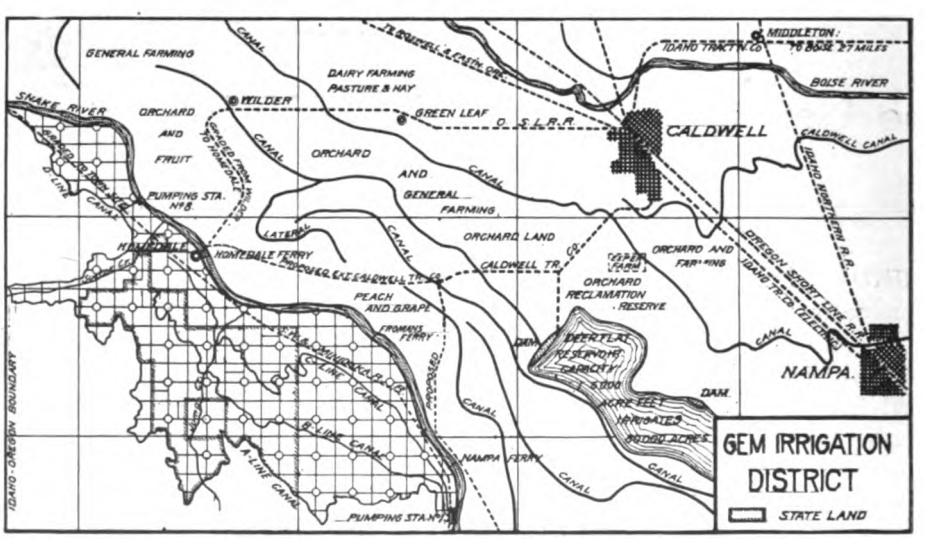


MAIN STATION ON SNAKE RIVER.

the state. These pumps will serve the entire tract when all the lands shall have been placed in cultivation. The immediate needs, however, require something less than 1500 hp., even when sufficient head of water is running in each of the four canals on the district, but it will always be possible, on account of the large number of pumping units, for the farmers to operate economically and with a consumption of power corresponding to their season's demand for water.

The entire output of all pumps is approximately 200,000,000 gal. per 24 hours, which amount will be appreciated when it is stated that, allowing a per capita consumption of water of 75 gal., this supply would care for the needs of a city larger than Chicago, or say 3,000,000 people.

The Gem irrigation district occupies one of the larger coves in the valley of the Snake river and at an elevation averaging approximately 2300 ft. above sea-level. Its westerly end is at the Oregon boundary, and it stretches along the south bank of the Snake river upstream for about 18 miles. Its greatest width is 7 miles in a north and south direction, and it contains 30,000



MAP OF GEM IRRIGATION DISTRICT.

acres, all irrigable and usable. Its general location with relation to the lower portion of the Boise valley will be noted from the illustration shown.

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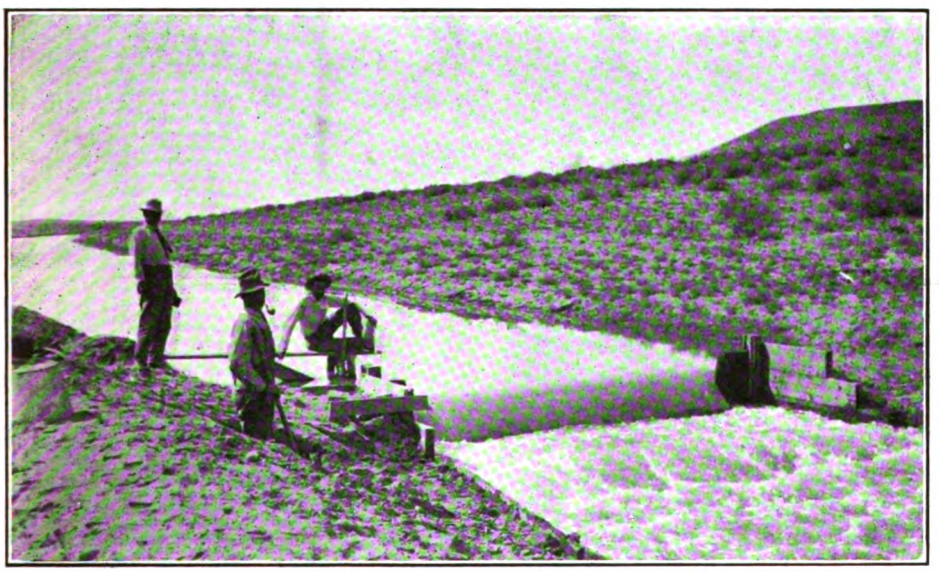
Its soils are of five varieties, although the greater part of the land consists of volcanic ash. Several water courses traverse the district and have deposited in their beds considerable alluvia. The greater portion of the remainder of the tract may be classed as wind-blown, and the fertility of the entire tract is well shown by its present vegetation. Expert agriculturists who have examined and reported upon the soil declare that it contains a great amount of plant foods which have never been leached from the soil because of the minimum rainfall in the valley. None of the land is stony nor with any surface hardpan. To quote from one expert's report, "its high agricultural value, together with the electrical conveniences for the comfort of the home, the mesa is well protected from extremes of climate, and the gentle slopes to the southward of the tract encourage a very satisfactory air circulation.

WOOD-STAVE PIPE FROM SUB-STATION.

It has been observed during this spring season that the lands immediately across the river and at similar elevation which lie under the famous Boise project have not been visited by the



FORTY-THREE SECOND FEET FLOWING OVER 12-FT. WEIR.

should make this a very attractive section, and will at once appeal to those who desire a location where their intelligent efforts applied to intensive culture will be rewarded by maximum crops."

The district lying some 500 ft. below severe frosts which have characterized the climate on the mesa and in the Boise valley.

The organization of this project is under the state law providing for the formation of irrigation districts, and it has been financed by a bond issue

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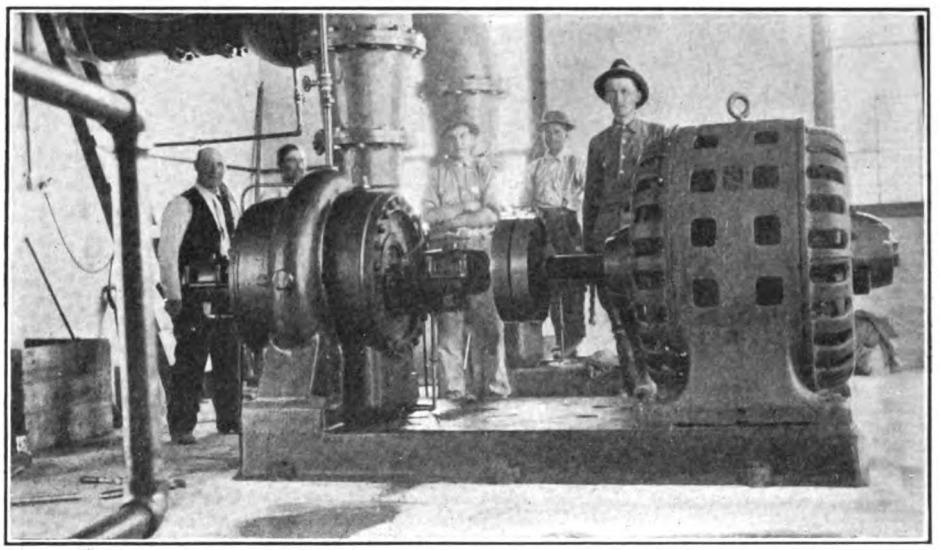
which, when all phases of the project shall have been taken care of, will not exceed $28 per acre. An especially favorable characteristic of the present situation lies in the fact that for three years enough electric power has been guaranteed to the district free of all cost to permit operation of the pumps for the estimated requirements, and for the same period the interest charges are also exceedingly moderate, averaging 20c. per acre. Under these conditions it will be possible for the settlers to confine their expenditures to the development of their lands, thus getting their properties into good earning condition before the fourth year, when first it will become incumbent upon them to meet their interest and power charges in full.

A branch of the Oregon Short Line has been laid into the tract from Nyssa to Homedale, the townsite some 4 miles from the west end of the tract, and surveys have been completed eastward from that point looking to the construction of the long-hoped-for water grade cut-off to Buhl, Idaho.

This project was undertaken in August 1911 by Canadian interests acting through the Crane Falls Power & Irrigation Co., Ltd., whose engineers, Smith, Kerry & Chace, of Toronto, have been in charge of the design and construction of the works now built and in operation upon the district. In 1912 the canals were excavated and the pumping stations built. Slick Brothers Construction Co., of Boise, and the Gills Construction Co., of Salt Lake City, Utah, have been engaged for these works.



SIXTEEN-INCH VOLUTE PUMPS IN SUB-STATION.

Forty thousand volt energy from the lines of the Idaho Railway, Light & Power Co. is transformed by this equipment of transformers and electric motors into mechanical energy driving the shafts of the centrifugal pumps supplied by Henry R. Worthington, Harrison, N. J. From the pumps and to the four canals the water is led through wood-stave conduits, the largest of which is 4 ft. 6 in., the smallest of which is 3 ft. inside diameter. These were supplied by the Washington Pipe & Foundry Co. of Tacoma, from ma-

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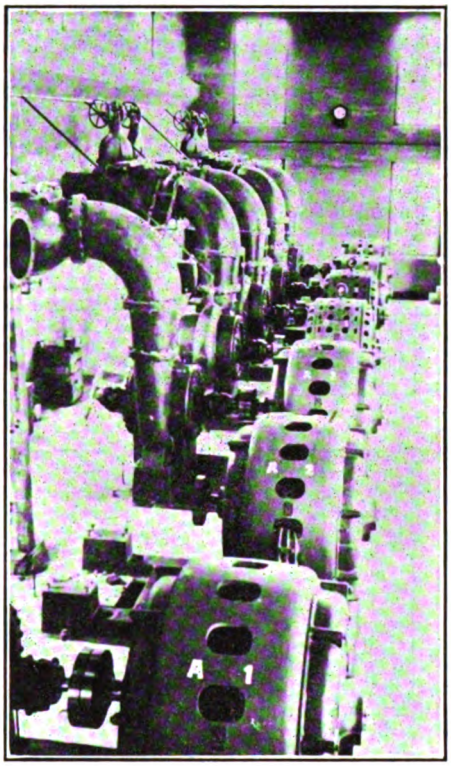
terial grown upon the Pacific coast, and the preliminary test, on May 4, showed remarkably small leakage, which condition will be appreciated when it is stated that these conduits contain 9662 lineal feet and operate under pressure as high as 75 lb. per square inch.

It has been stated that upon the canals of this district there is a greater percentage of concrete structures than even those built by the federal government either upon its Boise or Minidoka projects. These concrete structures, besides the wooden structures consisting of drops, headgates, flume trestles, bridges, and siphons, were built by Morrison-Knudsen Co. of Boise, which has rendered careful attention to the many details of this class of work. The steel flumes were manufactured by the Hinman Hydraulic Manufacturing Co. of Denver.

The state is vitally interested in the success of this project, as it owns nearly 11,000 acres in the heart of the territory. The greatest assistance which the state can give to the settlers who have earnestly and in the face of many difficulties looked toward the consummation of their desires, can be rendered by an early disposal of its large holdings to aggressive farmers, thus permitting the purchasers of its land to take advantage of the especially easy terms upon which the project has been purchased, and to get their newly purchased lands into a productive state during the first three years of the life of the project. A broad policy looking to this end is well warranted, as it is quite possible by a hesitation in the disposal of the lands and by an effort to speculate in their undoubted values, for the state to cause its holdings to be a millstone around the neck of those upon whom otherwise the burden of the assessments will assuredly fall.

To the would-be farmer this tract offers especial advantages on account of its excellent soil; its particularly easy terms both of purchase of land and payment of water, and on account of its proximity to railroad communication both by the Oregon Short Line branch above referred to and by a branch of the Caldwell Traction Co.,



ARRANGEMENT OF PUMPS IN MAIN STATION.

which has this spring entered a territory north of the tract and immediately across the Snake river. The townsite upon the tract will afford convenient sources of supply.

The illustrations show some of the characteristics of the structures upon the canals, as well as interior and exterior views of the pumping stations.

The consummation of this project has been the result of patient loyal endeavors by the directors of the Gem irrigation district. These express them-

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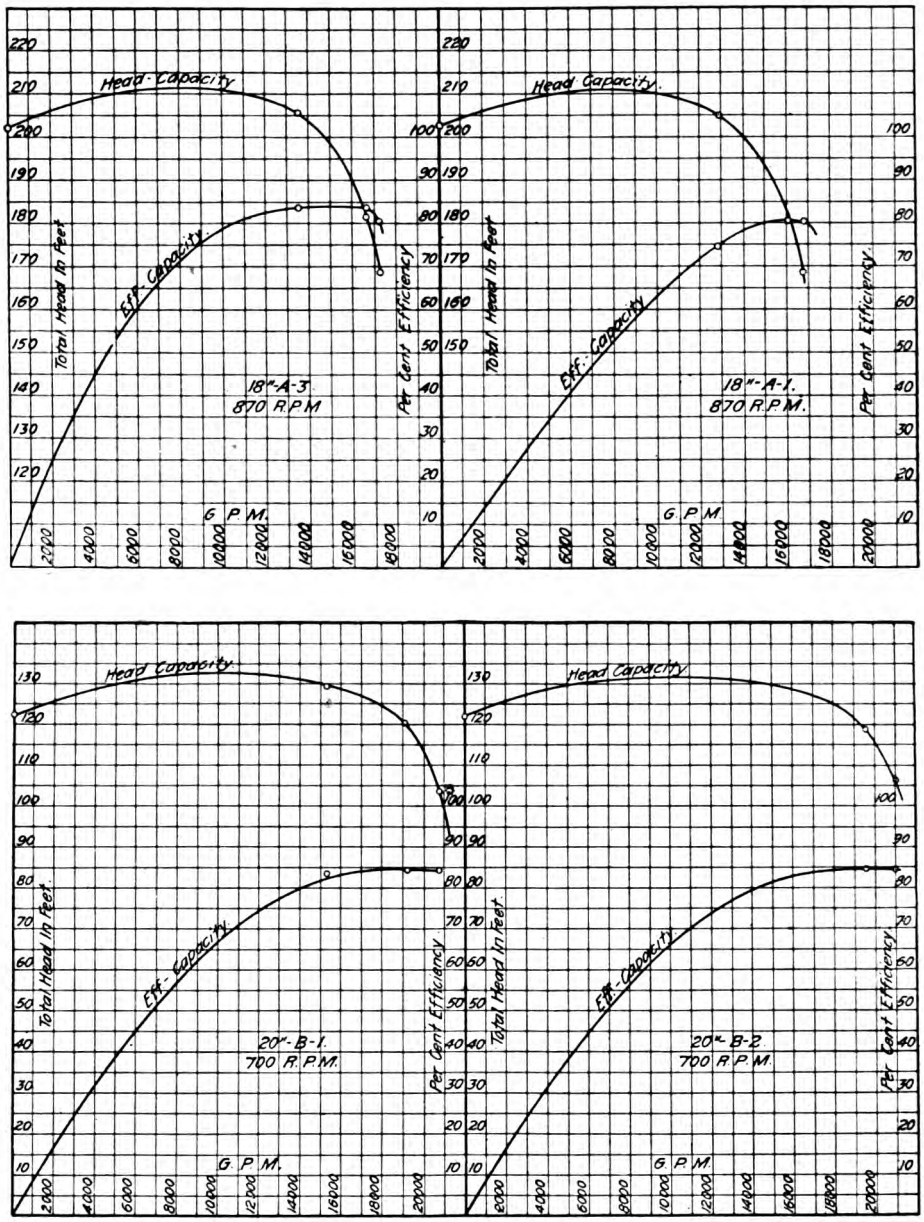
selves as satisfied that the works are of an excellent quality and that the conditions under which the district is starting its irrigation system are most helpful and the prospects for rapidly developing the tract are very bright.

There are two pumping stations in this district, known as station No. 1 and station No. 2. In station No. 1 there are seven pumps; the A pumps, of which there are three 18-in., discharging 38 cu. ft. per second, against 177 ft. head, connected to 1100-hp. motors; the B pumps, of which there



CHARACTERISTIC CURVES, WORTHINGTON DOUBLE-SUCTION VOLUTE PUMPS, CLASS B.

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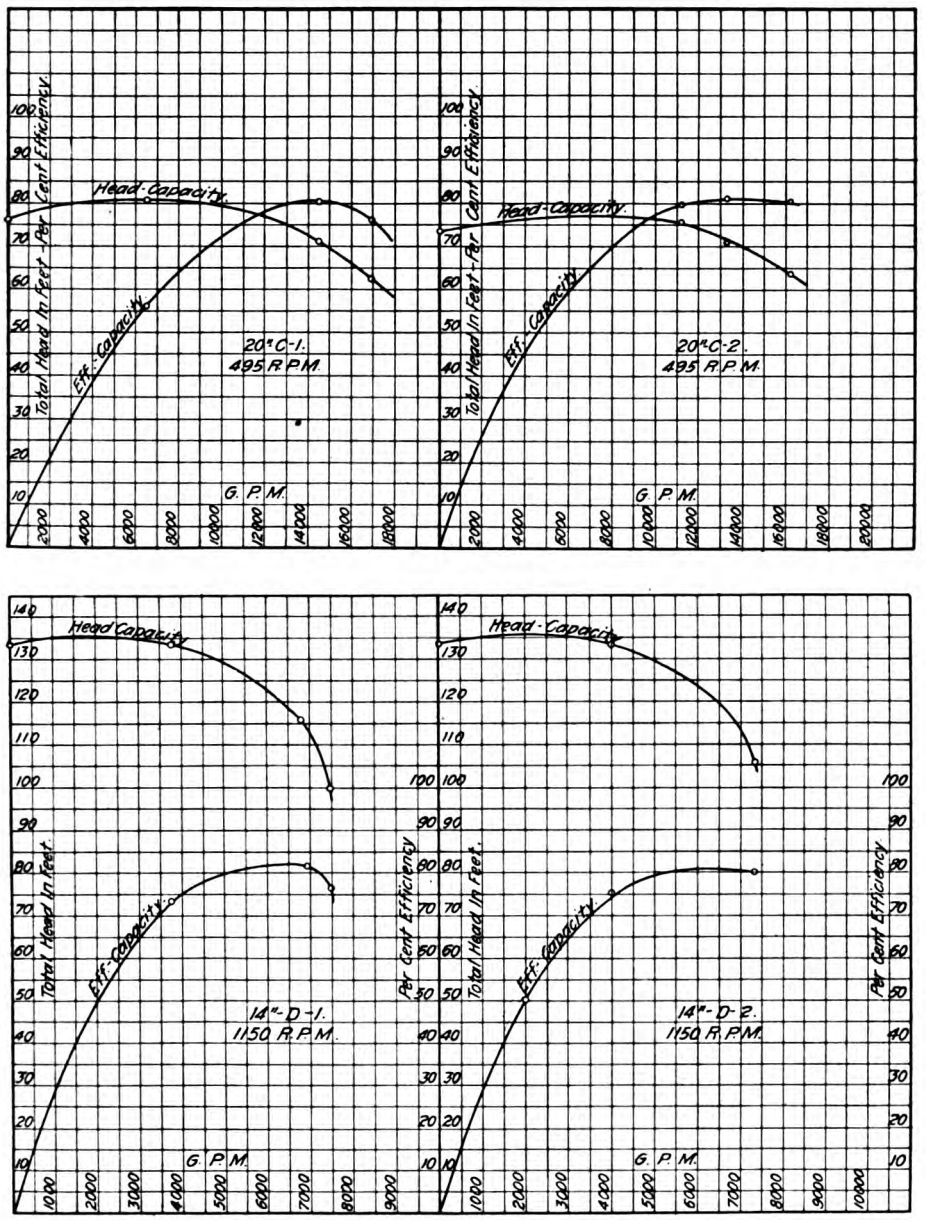
are two 20-in., delivering 43 cu. ft. per second against 108 ft. head, connected to 750-hp. motor; the C pumps, of of two 14-in. pumps, discharging 16 cu. ft. per second against 110 ft. head.

The total horse-power of this plant



CHARACTERISTIC CURVES, WORTHINGTON DOUBLE-SUCTION VOLUTE PUMPS, CLASS B.

which there are two 20-in., discharging 30 cu. ft. per second against 70 ft. head, connected to 350-hp. motor; the D units, which are in station No. 2 and consist would figure up to 5685 hp., while the capacity is 292 cu. ft. per second, which is equivalent to approximately 200,000,000 gal. per 24 hours. These pumps

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take their water out of the Snake river and discharge into four different lifts, as outlined above. The A canal covers a territory of 1176 acres and has 1255 stations 100 ft. apart; the B canal covers 7916 acres and has 693 stations 100 ft. apart; the C canal covers 6244 acres and has 596 stations 100 ft. apart; the D canal has 176 stations 100 ft. apart and empties into a patch canal 1¼ miles long and it covers an acreage of 2805.

The acreage which lies under the canals and which is possible for future irrigation and at present exempt from the district charges, but which may at any time enter the district, are A, 639 acres; B, 565 acres; C, 534 acres; and D, 526 acres, or a total of 2264 acres.

The official test on this pumping plant was run off between May 30 and June 6, 1913. The water was measured over Cippoletti weirs, which are of the trapezoidal type. The water was measured by means of a hook gauge. Corrections have been made for velocity of approach. The formula for which the discharge was measured over the weirs is $D = 3.3\frac{2}{3}\ LH^{3/2}$. No corrections have been made for any seepage losses in these canals, except in the D weir, in which we measured leakage that passed the headgate. The discharge pressure on the pump was measured by means of a pressure gauge. The distance from the water to the centre of the pressure gauge was added, to give our total head. The electrical horse-power input was measured by station instruments, consisting of a volt meter, ammeter, and power-factor meter. The speed was measured by an ordinary speed counter.

The power conditions in the test were not very satisfactory, as there was a considerable variation in the voltage and frequency. However, an attempt was made to run the test when power conditions were best.

The attached average results and curves will show that guarantees were exceeded in both efficiency and capacity of all except the A-1 pump, in which there was 600 gal. short. However, this shortage may possibly have been due to power conditions. The excess capacity which is given the district under the contract head, figures approximately 4500 gal. per minute. On the A and B pumps the efficiency guarantee was 80%, while on the C and D it was 79%. These guarantees have been exceeded in all cases.

A correction for difference in velocity head between the suction and discharge has been figured in the total head and efficiencies. As a gauge was placed 6 in. below the flange openings of the pumps, the diameter was taken where the pressure was measured, as 19 in. on the 20-in. pumps, 17 in. on the 18-in. pumps, and 13½ in. on the 14-in. pumps.

The representatives at the test were Mr. Van Buskirk for the district; Mr. Van Sittart for Smith, Kerry & Chase; and William Wilson and A. H. Borchardt for the Worthington company. The utmost care in making these tests was exercised.

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Long Lake Power Development

By E. P. KENNEDY*

LONG LAKE, which lies about 2 miles from the beach at an elevation of 727 ft., has an area of 3.1 square miles. It is situated near Speel river, between Ketchikan and Skagway, 35 miles southeast of Juneau, Alaska. Water measurements for eight months and an estimate for the remaining four give a yearly run-off of 21,757 million cubic feet, and as the drainage area is taken at 32.4 square miles, the above run-off amounts to 24 ft., or an equalized yearly flow of 689 cu. ft. per second. The initial plant will use 300 sec-ft., which is equivalent to a run-off of 10.4 ft. over an area of 32.4 square miles.

The power-plant is to be situated near Second lake, 2000 ft. from and 535 ft. below Long lake, and about 1½ miles from the beach. This plant will consist of two units, each of 5000-kw. capacity and each to be direct connected to a water turbine utilizing 300 sceond-feet.

To be assured of a continuous flow of 300 sec-ft., the lake will be drawn on by tapping with a tunnel or by a siphon to a depth of 12 ft., and the two spillways from the lake closed, thus raising the lake level 25 ft., giving an available storage of 37 ft. The cost of this power installation would be:

Power-house with two 5000-kw. units complete	$250,000
Pipe-lines, two 60-inch with headgates	93,594
Closing spillways from lake	10,000
Tapping lake	5,000
Contingencies and incidentals	3,000
Plant for construction	13,882
Total	$375,476

Or a capital cost of $37.54 per kilowatt or $27.95 per horse-power.

The cost of operating the above plant would be, per year:

General expense	$ 6,000
Operating labor	6,000
Supplies, etc.	4,000
Total	$16,000
Operating cost per year per kilowatt	$1.60
Interest and depreciation, 8% on capital cost	3.00
Cost of kilowatt-year	4.60
Cost of horsepower-year	3.43

To be assured of a yearly average of 10,000 kw., the generators should be run at 25% above normal capacity for 6 months of the year while there is a large excess of water, and thus provide for unforeseen shut-downs.

Surveyed lake area is 3.1 square miles, or 86,423,040 sq. ft., requiring 20 ft. in depth at this area to provide for the required storage.

This storage is obtained by raising the lake level 25 ft. and drawing on the lake 12 ft. The increased area obtained by raising the lake will make up for the decreased area by drawing the lake and also provide sufficient storage below the 2 ft. of ice.

Power estimate is based on a pipe-line loss of 1%, water-wheel efficiency of 82%, generator efficiency of 93%; total efficiency of 75% from the water. Three hundred second-feet under 542-ft. head at 75% will generate 10,320 kilowatts.

*Asst. Supt. Alaska Treadwell G. M. Co., Treadwell, Alaska.

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From flow measurements the following figures are obtained:

	Measured flow.	Required flow for 300 sec-ft.	From storage.
January	324,187,200	803,520,000	479,332,800
February	283,046,400	725,760,000	442,713,600
March	374,976,000	803,520,000	424,544,000
April	352,512,000	777,600,000	425,088,000
May	1,154,390,400	803,520,000	.....
June	2,947,104,000	777,600,000	.....
July	5,340,729,600	803,520,000	.....
August	4,860,492,480	803,520,000	.....
September	4,473,792,000	777,600,000	.....
October	803,520,000	803,520,000	.....
November	518,400,000	777,600,000	259,200,000
December	324,187,200	803,520,000	479,331,800
	21,757,337,280	9,460,800,000	2,510,210,200

DETAIL OF CONSTRUCTION PLANT

Horse tram from beach, 11,000 ft., 30-in. gauge, 20-lb. T-rail, 76 tons at $40 per ton	$3,040		
7335 ties, 6 by 8 by 48 in., equivalent to 117,328 ft. B. M., at $14 per M	1,642		
Labor and tools	3,000		
		$ 7,682	
Gasoline tow-boat		2,000	
2 barges at $3000		6,000	
1 donkey engine		1,400	
2 horses		600	
1 air-hoist			200
1 compressor with water-wheel and pipe for riveting			2,000
Riveting hammers, etc			1,000
Camp			2,000
Three cottages			3,000
Sawmill $600, cost absorbed in tram ties and cottages.			
Total cost of plant			$25,882
Allowance for plant after 6 months			12,000
Charged to power installation			13,882

DETAIL OF PIPE-LINE FOR LONG LAKE 60-IN. I.D.

Feet.	U. S. gauge.	Thickness, inches.	Safe lead.	Safe pressure.	Weight per foot.	Total weight.
500	3/16	0.187	139	60	150.25	75,125
166	1/4	0.250	185	80	197.50	32,785
166	5/16	0.312	231	100	244.00	40,504
166	3/8	0.375	277	120	291.25	48,347
166	7/16	0.437	323	140	337.75	56,066
170	1/2	0.300	370	160	385.00	65,450
331	5/8	0.825	462	200	478.75	158,466
355	3/4	0.750	555	240	572.50	191,787
Total						666,530

Velocity when carrying 300 sec-ft., 8 ft. per second; loss per 100 ft., 0.225.

Weight of two lines, 1,337,060 lb.; and estimated cost erected is 7c. per pound.

The steel of which the above pipe is made will have an ultimate tensile strength of 60,000 lb. per square inch. Thickness of pipe is figured from the formula:

$$\frac{\text{Diam. in inches} \times \text{pounds pressure}}{2 \times 10{,}000}$$

which takes care of the efficiency of joints and allows a sufficient factor of safety. The weight of above pipe is obtained from the formula: weight in pounds per foot (12.5 times diameter in inches times thickness in inches) plus 10 lb. This weight takes care of laps, rivets, asphaltum, paint, etc.

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The Engineering Digest

Hydro-Electric Plants at Estacada, Oregon*

By HERMANN V. SCHREIBER

THE extremely heavy precipitation on the nearby mountains and snow peaks, combined with the high fuel costs along the northern portion of the Pacific Coast, give conditions very favorable for development of large hydro-electric transmission projects. Several of such projects centre about Seattle and Portland, and other systems are being developed around the smaller cities.

At Portland the Columbia river, which is the largest stream in the northwestern section of the United States, breaks through the Cascade mountains and flows westward to the Pacific past Portland, where it is joined by the Willamette river flowing from the south. Both these streams and some of their branches are navigable and also provide considerable power. Flowing from the east into the Willamette river south of Portland is the Clackamas river, which finds its sources among the peaks of the Cascade range south of Mount Hood. This river, being fed from several snow-covered peaks and forest reserves, has a comparatively steady flow, and because of its rapid fall and high banks offers numerous attractive power-sites.

The Portland Railway, Light & Power Co., controlling the electrical market in and around Portland, having already acquired a development on the Clackamas river about 40 miles southeast of Portland with an interurban railway connection partly paralleling the streams, naturally investigated the further possibilities for development on this stream as soon as its increasing load conditions indicated that it would require more power than its existing plants could produce.

Sellers & Rippey, consulting engineers, made a careful investigation of the stream-flow conditions, and it was found, first, that the annual rainfall was extremely high, but there was a dry season during the summer when no precipitation whatever occurred over most of the drainage basin. From the few years' records available, however, it was found that the stream flow during this dry season was very well maintained, apparently from the melting snows of the mountain peaks, and while one or two large floods were recorded, they did not appear to be excessive in view of the extremely heavy precipitation. After considering these conditions it was determined, therefore, that while a seasonal storage would be advantageous, the flow coincided sufficiently well with the ordinary electrical load conditions that additional power developments could be justified at once.

This report, together with our own examinations, indicated that any extensive hydro-electric development should be provided with a substantial cut-off at the base of the dam, and because of this feature, together with the variable bearing values, some form of hollow dam would probably meet the general requirements better than the standard form of solid dam.

Examining the various sites available along the river above and below the existing plant, we found one site about two miles upstream at which the superficial conditions appeared to be good enough to justify further sub-surface investigations. We then immediately started several core-drills at work drilling holes, some as deep as 250 ft., over the entire space which was available for location of a dam. While this work was proceeding, the growth of the power market indicated that a smaller plant, possible of quicker construction, would have to be provided before the plant proposed for this site could be built, and it was therefore suggested that additional investi-

*Abstract from *Proceedings* Engineers Club of Philadelphia, October 1913.

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gations should be made elsewhere along the stream to determine whether any other site might be available for immediate development.

After a review of the conditions downstream, a site was then selected near Estacada, about five miles below the existing plant, where prospects for quick and economic development seemed to be quite favorable. Core-drillings at this point, covering four possible locations, indicated that one of them, containing an island which would be included in the construction, might considerably reduce the amount of material required and at the same time make the construction much more convenient by facilitating the diversion of the stream during the rainy season. After the preliminary core-drilling had been completed, this site was decided upon for immediate construction and the particular type of hollow dam best adapted to the consideration.

Our previous experience in this direction, together with numerous studies of comparative costs and other inherent advantages in various types of hollow dams, prompted the selection of the Ambursen type because of the availability of an experienced construction orgainzation which could be started at once on the work and push it to completion without delay.

The dam consists of a series of buttresses running parallel to the thread of the stream and covered on the upstream and downstream sides with a reinforced concrete deck which is carefully embedded in the foundation material on the upstream side and curved so as to throw off the water on the downstream side. The upstream portion, known as the deck, is inclined 45° with the vertical, having a thickness varying from 20 to 48 in. on a spacing between buttresses of 14 and 18 ft. The apron or downstream portion of this cover makes an angle of 30° with the vertical and has a thickness averaging about 18 in. The deck and apron are both reinforced by horizontal corrugated rods and additional rods placed vertically as an extra precaution against weakness in joints and temperature strains.

The buttresses in the rollway section are spaced 18 ft. on centres, and in the power-house or intake section 14 ft. on centres, the thickness varying from 15 to 38 in. with special spread at the base in proportion to the load imposed. These buttresses, being built in horizontal lifts of 12 ft., are reinforced at the bottom of each lift and at the top of each lift as a precaution against temperature strains and low bearing value of foundations. The upstream ends of the buttresses are provided with haunches, which give 18-in. seats for deck slabs and provide a tongue between the haunches on each side, so that the deck slab is not continuous through the crest. The apron slabs are laid directly across the buttresses and are continuous.

This general description covers the usual hollow dam of this particular type, and as constructed at Estacada there were added a series of sluice-gates together with the usual closing device in the left or main river channel, and on each end of the construction there was provided a suitable reinforced concrete abutment. Across the top of the island, which subsequently was discovered to be of comparatively little value, the construction was continued and so extended as to protect the island from erosion.

To the right of the spillway section, which had a maximum height of about 86 ft., the bulkhead section extended to a greater height of 15 ft. and included on the left side of the island an intake section for five 11-ft. penstocks. Immediately adjoining the intake section there was included a fishway tank and ladder of reinforced concrete which was built on the side of the island from the tailrace.

At the intake section an old gorge, apparently forming a prehistoric river bed, was uncovered extending about 30 ft. below the ordinary river bottom, and it was necessary to practically fill this with concrete to form a foundation for the dam and power-house. The power-house immediately adjoined the dam on the downstream side and contained five 6000-hp. turbines and 3300-kw. generators with step-up transformers and high-tension equipment inside the bulkhead portion of the dam.

Access is provided by means of a railway connection extending out over the bulkhead portion of the dam into an enlarged portion of the gate-house, where a crane is provided for unloading the cars and lowering the materials to the power-house floor-level. From this point a small truck is provided to transfer these materials into the power-house, where they are accessible by the power-house crane.

The tailrace extends from the power-house to the river channel, being specially excavated around the island to a point where there is the least possible interference from

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the spillway discharge. To provide adequate rack area tne deck of the dam was set back and steel framing erected from the point of offset to the water surface. In this way space is provided back of the racks for easy access of the water to the intakes, and the head gates could be installed without unduly interfering with this access.

The penstocks are supported by frequent struts extending from the buttresses on each side, and, being 11 ft. in diameter, leave little clear space between the buttresses, which are spaced 14 ft. on centres. The intakes for these buttresses are supported by an extra thickness of deck, with additional reinforcement in the deck and buttress to withstand vibration during operation.

Because of the extreme flood conditions, the power-house foundations are of solid concrete with flood protection for a height of 14 ft. above the floor-level. The penstocks enter the turbines beneath the floor-level through a large cast iron Y pipe, and the twin volute cast iron casings on the turbines discharge into a central cast iron draft tube which passes out through the foundations into the tailrace.

The generators are provided with ample ventilation and have a direct-connected exciter on the outboard end of each shaft. To each generator there is direct connected a 3-phase, 60-cycle, 33,000-volt delta and 57,000-volt Y transformers placed in the alternate spaces between the penstocks. The buttresses immediately above them are provided with necessary busbar compartments for high and low tension busbars, oil switches, lightning arresters, etc., providing connection to the transmission line to Portland.

In the design of the dam the following materials and stresses were specified.

Concrete:

Deck and apron	1:2:4
Buttresses	1:3:6

Reinforcing steel:

Johnson corrugated square bars, 50,000 lb. elastic limit and 80,000 to 100,000 lb. ultimate strength.

Stresses:

	Lb. per sq. in.
Modulus of elasticity of concrete	1,500,000
Modulus of elasticity of steel	30,000,000
Compressive stress in concrete	500
Shear in concrete	75
Tension in concrete	0
Tension in reinforcing steel	15,000
Base pressures	100

Before beginning actual construction it was, of course, necessary to determine definitely the proper method of reducing, as far as possible, the seepage through the porous foundation material. In this consideration we had the benefit of quite extended borings at the upper site, together with several experiments made at that point, but were unable to find the same conditions had been met and satisfactorily treated elsewhere.

The most definite and positive cut-off wall which could be provided would, of course, be a steel or concrete diaphragm across the entire width of the damsite, and several schemes were worked out to demonstrate the feasibility of such a construction, but as the cost would be large and the time required would be considerable, a modified scheme was finally installed providing for three rows of holes to an average depth of 50 ft., all of which were pumped full of cement grout under high pressure.

In considering any modified or compromise form of cut-off wall the integrity of which was not self-evident, it was necessary to provide some means to demonstrate its efficiency because of the importance of the work involved. The purpose to be served by such a cut-off wall was, first, to minimize the upward pressure; second, to prevent percolation; and third, to overcome any structural weakness in the foundation.

In the form of cut-off wall finally adopted the holes were spaced in three rows, each 6 ft. apart. The outside rows of holes were drilled first and the grout pressure applied by means of a Canniff pneumatic grout mixer and injector until the pressure rose to 200 lb. if possible. Each hole was drilled and grouted as soon as completed, some of the holes requiring a considerable quantity of cement, while others could not be entirely tightened, and permitted the pressure to be raised to only about 50 lb. At times the grout would escape to the surface, and in those cases it became necessary to discontinue grouting on that particular hole until the cement had somewhat hardened, when pressure was again applied.

Following the drilling and grouting of the outside rows, holes were drilled along a row midway between and pressure applied without grout in order to test the efficiency of the diaphragm formed by the grout as distributed from the first set of holes. Where the results were not satisfactory, additional holes were drilled in the outside rows and, after grouting, further tests were

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made along the centre line of holes until satisfactory results were secured. This cut-off wall was situated immediately upstream from the point at which the deck joined the river bed, and after completing the drilling and grouting the river bed was excavated for a depth of 4 to 6 ft. and solid concrete filled in and joined to the concrete of the deck in order to form a complete impervious cut-off wall.

After the completion of the dam and filling of the pond, two holes were drilled into the river bed inside the dam about 30 ft. downstream from the cut-off wall, which gave a static head within 13 ft. of that due to the water in the pond.

A careful examination of the river bed below the dam during the period of filling indicated that the seepage was not sufficient to cause excessive erosion, and there is reason to believe that the gradual deposit of silt in the river bed above the dam will practically eliminate such seepage as does occur. To complete this work required drilling of 34,000 ft. at a cost, including grouting, of $1.55 per foot.

The scarcity of suitable construction materials necessitated a careful investigation, with the result that a satisfactory sand bank was uncovered and arrangements made to select stone from the only available quarry along the railway right-of-way. The cement business on the Coast not being in an entirely satisfactory condition, a careful investigation of all the principal plants which might furnish material for the work was made, with the result that a satisfactory contract was closed for sufficient material to construct this work and meet the general construction requirements of the company for several years afterward.

The construction equipment included steam drills, derricks, cableways, and narrow gauge railway system, together with the six core-drills, air-compressors, and grouting tanks. Three concrete-mixers were erected with suitable supply and storage bins, and a large construction camp was established.

The work first proceeded with the uncovering of bedrock material on both banks, and on the island above the water-line, and it was discovered that the island did not prove to be as great an advantage as was at first expected, because of the existence of an old stream channel and a considerable quantity of clay on one end. This condition, together with the necessary excavation of an old river channel at the site of the power-house, greatly increased the excavation above the amount expected.

The first concrete work was begun along the right-hand river bank and the first lift of one buttress was erected in the middle of the right-hand channel in order that it might serve as one portion of a coffer-dam to divide this channel when the work was being completed. By placing the cut-off wall several feet upstream from the base of the dam, it was possible to proceed with the drilling and grouting practically independent of the main portion of the construction.

Across the island this cut-off wall was extended through a slot excavated in the island almost to the water-level with a sloping downstream face, which when covered with 2 ft. of concrete formed the upstream deck of the dam at this point.

The entire construction, from beginning of excavation to delivery of power at Portland, required approximately 17 months, the largest force employed at any time being 655 men. In the construction of the dam the buttresses were built in lifts of 12 ft., groups of three and four buttresses being built at one time according to the space which was available for this purpose. The deck and apron was usually placed on the buttresses soon after completion of each lift, so that in this way, with the struts between the buttresses, each buttress was properly supported as it was erected.

At the power-house site, after the whole chasm had been filled up, the foundations were erected to the point where the penstock elbows and draft tubes could be placed, then the additional concrete was placed up to the floor line. The end walls of the power-house formed protecting walls along the river bank on one side and the island on the other side. The reinforced concrete superstructure of the power-house and gate-house was further stiffened by structural steel framing to support the cranes and roof trusses.

The work proceeded during the entire construction period, though its progress was somewhat interfered with by the heavy rains of the winter season. Fortunately, however, there were no excessive floods, and the coffer-dam problems were not serious. The closing of the dam was effected after completion of the entire structure with the exception of its temporary openings through the base of the spillway portion, which together with the three sluice-gates carried the entire stream flow during the dry season

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just preceding the completion of the structure.

The installation of the machinery was pushed along as rapidly as the completion of the dam permitted. On account of the location of the power-house with respect to the dam, it was necessary to lower the apparatus from the top of the bulkhead to the power-house floor-level, and the erection of the high-tension apparatus inside the dam required that the buttress in back of the power-house be completed and properly covered before installing this portion of the equipment. This was done, however, and as the transmission line was completed about the same time, it was possible to transmit power to Portland very soon after the water was first passed over the spillway.

Frank R. Fisher, who was resident engineer in charge during the construction, kindly furnished much of the construction data given above and which has been used as a basis for this article.

Petroleum and Natural Gas in the Mid-Continent Field*

By CHAS. N. GOULD†

THE Mid-Continent oilfield, as the term is generally used, includes an area approximately 200 miles long from north to south, and 100 miles wide, in southeastern Kansas and eastern Oklahoma. The limits of the productive field have not yet been sharply determined, and probably will not be for many years. The most northern points at which oil has been found in quantity is near Paola, Kansas, some 50 miles southwest of Kansas City. The most southern point is near Coalgate, Oklahoma. The southeastern part of the Mid-Continent field extends from Oklahoma into the vicinity of Fort Smith, Arkansas. The westernmost limit, as at present developed, is at Blackwell, Kay county, Oklahoma. The area within which oil and gas have been found in commercial quantities contains approximately 20,000 square miles.

The rocks in which the hydrocarbons occur throughout the two states consist entirely of sediments of Pennsylvania age which lie, usually unconformably, above the Boone chert, a limestone of Mississippian age. This limestone, popularly known to the oilmen as the 'Mississippi lime,' outcrops in the region east of Grand river, in northeastern Oklahoma and southeastern Kansas. The Pennsylvanian formations, as exposed in the Mid-Continent field, consist of alternating sandstones, shales, and limestones with an occasional bed of coal. Throughout northern Oklahoma and Kansas the Pennsylvanian rocks dip west at rather constant angles, varying from 50 ft. to the mile near their eastern exposure, to less than 20 ft. to the mile in the western part of the area. In the southern part of the Mid-Continent field the rocks have been folded into a series of anticlines and synclines.

South and west from the region of exposure of the Boone chert, the Pennsylvanian sediments thicken rapidly, particularly in the basal portion of the series. This fact may be illustrated by comparing the thickness in various parts of the area of the Cherokee shales, the lowermost formation of Pennsylvanian age, which lies below the Fort Scott limestone. In southern Kansas the thickness of the Cherokee shales approximates 450 ft. On passing southward the Pennsylvanian rocks below the Fort Scott limestone thicken gradually until, in the region of McAlester, in east-central Oklahoma, the combined thickness of the Pennsylvanian sediments, below the Calvin sandstone, which is the approximate southern equivalent of the Fort Scott limestone, aggregates 10,000 feet.

In southern Kansas a considerable part of the rocks of the Pennsylvanian series is limestone. On passing south into Oklahoma, the various limestones gradually become thinner and many of them disappear, while sandstones become more and more prominent, and shales become relatively thicker. A cross-section of the Pennsylvanian series, taken 50 miles north of the Kansas line, would show that more than one-fourth of the thickness of the Pennsylvanian sediments at that place is limestone. A cross-

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†Oklahoma City, Oklahoma.

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section taken at Tulsa, Oklahoma, 60 miles south of the Kansas-Oklahoma line, would demonstrate that here not one-twentieth of the thickness of the series is limestone.

The petroleum and natural gas found in the Mid-Continent field occur altogether in ledges of sandstone which occur interstratified with shales and limestones. In the great majority of cases the stratum lying above the oil-bearing sand, that is to say, the cap rock which holds the oil down, is shale; but in a few instances it is limestone. All the oil-sands in the Mid-Continent field are more or less lenticular. Some of the more persistent of the sands, as for instance the Bartlesville sand and the Wayside sand, are believed to occupy an area of several thousand square miles, while others are but a few square miles in area. Even the most persistent of the sands, however, often vary much in thickness, even in short distances.

The term 'pool' is applied to a small area from which oil or gas has been produced. The size of a pool in the Mid-Continent field varies from a fraction of a square mile to several square miles. For instance, the Flat Rock pool, near Tulsa, Oklahoma, is 2 miles long and 1 mile wide. Glenn pool is 12 miles long and 5 miles wide. Hamilton Switch pool occupies less than a square mile. The size, shape, and location of the various pools in different parts of the Mid-Continent field differ materially. At the present time there are more than 80 separate pools and new ones are constantly coming to light.

More than three-fourths of the oil and gas so far produced in the Mid-Continent field has come from ledges of sandstone contained in the Cherokee shales, which, as stated above, occupy the basal portion of the Pennsylvania series in Oklahoma and Kansas. Many of the oil-bearing sands have received local names such as Bartlesville, Tucker, Burgess, Glenn, Taneha, Dutcher, Layton, and Cleveland.

It is believed that the oil-bearing sands reach the surface in southeastern Kansas and eastern Oklahoma, in the region about midway between the exposures of the Boone chert and the Fort Scott limestone, where they form a row of timber-covered sandstone hills and ridges. These sandstones disappear to the westward beneath overlying limestones and shales. In the Shallow field in eastern Nowata county these sands occur at depths varying from 300 to 800 ft. beneath the surface. The local name here applied to these sands is usually that of the pool in which they were first found, as Alluwe, Coodys Bluff, and Childers sands. Near Bartlesville and Tusla they lie at depths varying from 1200 to 2000 ft. beneath the surface. In the Cleveland pool the same sands are 2700 ft. deep.

Above the horizon of the Fort Scott limestone, which is known to the driller as the 'Oswego lime,' there are a number of sands, which, in the western part of the Mid-Continent field, have yielded considerable quantities of oil and gas. In Washington and Osage counties in northern Oklahoma and Chatauqua and Montgomery counties in southern Kansas, much of the oil has been obtained from two sands known to the driller as the Wayside and the Peru sands, which occur at from 600 to 800 ft. beneath the surface in these places. Both of these sands lie above the Fort Scott limestone. The Layton and Cleveland sands found in the Cleveland and Cushing pools are at the approximate horizon of the Peru and Wayside sands. The oil and gas in the Ponca City pool and the gas in the Blackwell pool, both of which lie at a higher geological level than any of the other oil pools in Oklahoma, come from sands still higher in the Pennsylvanian series than the Layton and Cleveland sands. In addition to the sands mentioned above, which are usually quite persistent and are believed to occur in a number of separate pools, there are, in the Mid-Continent field, many so-called 'stray sands,' that is to say, sands containing oil and gas which seem to have a rather limited areal extent.

In many of the pools throughout this region there is but one producing oil-sand, while in others there are several sands. For instance, in the vicinity of the world-famous Glenn pool, which during the past 6 years has produced 120,000,000 bbl. of oil, there are four producing sands known as the Red Fork sand, which lies at a depth of 1300 ft., the Glenn sand at 1500 ft., the Taneha sand at 1700 ft., and the Dutcher sand at 2200 ft. In the Bartlesville field there are eight productive oil-sands, as follows:

	At feet.
Unnamed sand	250
Unnamed sand	400
Wayside sand	650
Peru sand	825
Oswego sand	100
Squirrel sand	1100

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Bartlesville sand 1250
Burgess sand 1500

In some parts of the Bartlesville region as many as four of these sands have been found productive on the same property, and it is a common occurrence for two of them to produce oil. In the Cleveland field there are five producing sands, in the Cushing field five, and in the Ponca City field seven sands that produce oil or gas in commercial quantities.

As has been stated above, all the sands in the Mid-Continent field are more or less lenticular, and often thicken and thin rapidly in short distances. Not enough drilling has yet been done throughout the region to demonstrate with certainty the continuity of the various sands. To cite a specific example, most oilmen and geologists who have studied the conditions now believe that the Bartlesville sand, which has produced such immense quantities of oil in northern Oklahoma, extends uninterruptedly from southern Kansas through Washington and Osage counties, Oklahoma, as far as the Bird Creek and Flat Rock fields, near Tulsa. The same sand is also supposed to occur at Cleveland. In other words, the Bartlesville sand is commonly believed to be continuous over more than 5000 square miles.

In point of fact, however, no one knows with certainty that this is true. It is not possible in the light of present knowledge to either prove or disprove the assertions. No one can be certain that the sand which contains oil or gas at a depth of about 1100 ft. near Independence, Kansas, is the same sand which contains oil at 1200 ft. at Bartlesville, at 1300 ft. in the Flat Rock field near Tulsa, and at 2400 ft. at Cleveland. Sufficient investigations have been made, however, to demonstrate with approximate certainty that the oil-producing sands in these four widely separated localities, occurring at the depths mentioned, are situated at about the same geological horizon. Taking into account, however, the known lenticular nature of all the Pennsylvanian sands in the region, it is as yet too early to make a definite prediction as to the continuity of this or, in fact, of any other sand in the Mid-Continent field. It is quite possible that further development will show that various lenticular sands appear and disappear throughout this region, and that the Bartlesville sand, so-called, is by no means continuous.

The two dominant factors which appear to govern the accumulation of petroleum and natural gas in the Mid-Continent field are (1) the thickness of the oil-sands, and (2) the structure of the rocks.

It goes without saying that, other things being equal, the thicker the sand the more oil will be contained therein. The Glenn pool, one of the most noted in the world, owes its prominence largely to the fact that the Glenn sand averages from 75 to 100 ft. in thickness at this place, thus providing an immense reservoir for the storage of petroleum. The Bartlesville sand averages from 50 to 60 ft. thick, and scores of millions of barrels of oil has been produced from it. The Cleveland sand, which is also a thick sand, has produced a vast amount of petroleum.

On the other hand, many sands, as for instance the Wayside, Peru, Childers, Alluwe, and others, which average 20 to 40 ft. in thickness, have produced smaller amounts of oil. Generally speaking, the wells in the thicker sands have initial productions varying from 100 to 1500 bbl. of oil per day and settle after two to three years to 20 to 100 bbl. per day. The wells in the thinner sands usually have initial productions of from 30 to 200 bbl. per day, and settle to 5 to 20 bbl. per day. Thus it will be seen that, other things being equal, it is very much more profitable to operate the thicker sands. It must be remembered, however, that the thinner sands are often comparatively shallow, occurring at depths of from 300 to 1000 ft., while the thicker sands usually lie at depths varying from 1200 to 3000 ft. beneath the surface.

The usual cost of drilling a well to the shallow sands, where an initial production of 50 bbl. per day may be expected, varies from $1000 to $3000, while wells 2200 ft. deep in the Cushing field, where the initial production averages 500 bbl. per day, cost from $8000 to $12,000 to drill and equip. It will be understood that in case any considerable number of unproductive wells occur in the region of deep sand the operation may be at a loss, but in case the wells encounter large amounts of oil, the operation is extremely profitable. The general experience throughout the field has been that operation in the thinner sands in the shallow fields is a far safer investment, while the operation of the deep sands is more speculative, but with the possibility of very much larger profits.

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A second factor which governs the accumulation of oil in the Mid-Continent field is that of the structure of the rocks. Throughout the greater part of this region the general structure is that of a broad monocline. The normal dip of the rocks is to the west, decreasing from 50 ft. to the mile near the eastern outcrop of the Pennsylvanian series to 20 or 10 ft. to the mile in the western part of the Mid-Continent field. In many places, however, this western dip of the rocks has been interrupted by local folding. These folds are usually not strongly marked, and in fact are often inconspicuous. In many, perhaps most, cases the folds are in fact nothing but terraces, or 'arrested anticlines.' That is to say, the rocks in certain localities, instead of having the normal dip to the west, lie nearly level. In comparatively few places throughout the greater part of the field well marked eastern dips may be observed.

Careful studies of geological conditions have demonstrated that there is in the Mid-Continent field a rather definite ralation between structure of rocks and occurrence of oil and gas. Those who are considered to be the best authorities on the subject do not hesitate to say that, so far as observation goes, practically every oil pool in the Mid-Continent field may be accounted for by structure. It must be admitted, however, that it is not always possible to determine this structure from surface observation, so that a careful study of well records is often necessary to determine it; but, when once understood, the relationships between structure and production are usually obvious.

In the southern part of the area occupied by Pennsylvanian rocks, that is to say, in the region from Muskogee southwest to Atoka, and southeast to Fort Smith, Arkansas, the general western dips noticed farther north give way to a series of alternating anticlines and synclines.

There has been no great amount of drilling in this region, and very little petroleum has so far been found therein. It is, however, a significant fact that, throughout this region, in practically every known case where drilling has been done along anticline folds, natural gas has been found. The gas-fields near Fort Smith and Manfield, Arkansas, and near Poteau, Spiro, Kinta, Red Oak, and Wardville, Oklahoma, are situated on or near the axis of well marked anticlines. Up to the present time not enough drilling has been accomplished, throughout this part of the Mid-Continent field, to demonstrate the absence or presence of oil in quantity. It is altogether probable, however, that extensive operations will reveal the presence of considerable amounts of petroleum.

Within the developed portion of the Mid-Continent field where, as stated above, the anticlines are not so conspicuous as in the regions just discussed, the largest oil pools almost invariably occur where an unusually thick sand underlies an anticlinal fold, or a terrace. The Bartlesville, Glenn, Cleveland, Cushing, and in fact all the larger pools that have produced unusually large amounts of petroleum, contain this very favorable combination of thick sand and structure. In many instances, however, oil has been found in considerable quantities in regions where there is little or no evidence that the normal western dip of the rocks has been interrupted. Under such conditions, however, the drill reveals the fact that the oil-sands are unusually thick. Instances of this kind occur in certain parts of the Bartlesville pool, in the Bird Creek pool, in the Shallow field, and in many of the pools in the Osage Nation.

The production of petroleum in the Mid-Continent field increased from 74,714 bbl. in 1900 to 59,343,850 bbl. in 1911.

During the past year there has been more development than ever before in the history of the field. This may be accounted for by the steady advance in the price of petroleum. In 1908 the petroleum in the Mid-Continent field sold for 35c. per barrel. At the time of this writing, May 1913, the price is 88c. per barrel, and it will probably increase.

Within the past few months there has been much prospecting in all parts of the Mid-Continent field. The Cushing pool, which bids fair to rival the world-famous Glenn pool, was first opened in March 1912. Its daily production is now 100,000 bbl. Within the year the known areas of a number of older pools have been materially extended, and a number of new pools have come to light.

A region occupying some five counties in southwestern Oklahoma, which has heretofore remained unexploited, is now occupying much attention. Within the past year a number of wells have been drilled throughout this region, and practically all have produced oil or gas. Geologists who have studied conditions in this part of the state

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are of the opinion that this field, when developed, may rival the field already developed in the northeastern part of the state.

The amount of natural gas produced in the Mid-Continent field is very great. At least 90% of all the oil wells so far drilled contain natural gas. In many cases the wells produce gas only; however, gas and oil usually occur in the same sand. In many cases after the gas in a well has been practically exhausted, oil will be produced. To use the drillers parlance, 'the well drills itself into oil.'

The capacity of gas wells of the Mid-Continent field varies up to 50,000,000 cu. ft. per day. Some of the most extensive gas fields so far discovered lie near Iola, Independence, and Caney, Kansas, and Copan, Bartlesville, and Collinsville, Oklahoma.

A well recently drilled to a depth of less than 700 ft. in the new field near Loco, Stephens county, southwestern Oklahoma, is producing 25,000,000 cu. ft. of gas per day.

The gas from the Mid-Continent field is utilized both for manufacturing purposes and for domestic use. Gas from this field, supplied the greater part of the cities of Oklahoma and eastern Kansas, and has been piped as far as Joplin, Kansas City, and St. Joseph, Missouri. Much of so-called casing-head gas is now being utilized for the manufacture of gasoline or petrol, there being about twenty-five gasoline plants in operation in the field.

The waste of natural gas in this field has been enormous. Legislation has checked, but has by no means stopped, this gigantic waste. At the present time tens of millions of cubic feet of the most valuable fuel is being dissipated into the air each day. Yet for this negligence there seems to be no immediate effective remedy.

At present there is no way of estimating the amount of natural gas now available in the Mid-Continent field, but it is probably between one billion and two billion cubic feet per day.

There is no means of knowing accurately the possible extent of the Mid-Continent field, but, taking into account all the available data, including the stratigraphy and structure of the rocks, and the known occurrence of oil and gas under existing conditions, it may safely be estimated that, at the present time, not over one-fourth of the future available territory in Oklahoma and Kansas has yet been drilled. New fields are constantly coming to light and the limits of old ones are being extended.

Many of the wells now in operation have been producing oil for fifteen years, and are by no means exhausted. At the present rate of development, it will be many years before the productive area of the fields has been determined. It will be many more years before it all will be drilled. There need be no surprise if the Mid-Continent field is producing both oil and gas one hundred years from this date.

Utah Rock Asphalt on Salt Lake Streets*

By L. O. HOWARD

MOST of the rock asphalt comes to Salt Lake in boxcars and is unloaded in wheelbarrows by two men, who dump it along a long platform. Men with sledges break it down from pieces 1 ft. in diameter to a size which will go into a No. 2 Williams crusher, where it is pulverized. A gang of 12 men prepares the rock and feeds it to the pulverizer. Because of the nature of the rock, it will pack in any kind of a jaw-crusher. The ground material is picked up by a bucket-elevator, discharged to a bin, and drawn off into wagons, by which it is hauled to the job. Owing to the tendency of the rock to merely deform instead of cracking, it is necessary on warm days to chill it with water when crushing.

The material is distributed along the street ahead of the work, and, as paving proceeds, is shoveled in 1-ton lots into a charging hopper of a Koehring heater, where it is subjected to an oil flame under blast.

As shown in the illustration, this heater consists of a revolving cylinder, in which the asphaltic material is thoroughly mixed and heated. The specifications of the city of

*Abstract from *The Salt Lake Mining Revi ew* of Oct. 15, 1913.

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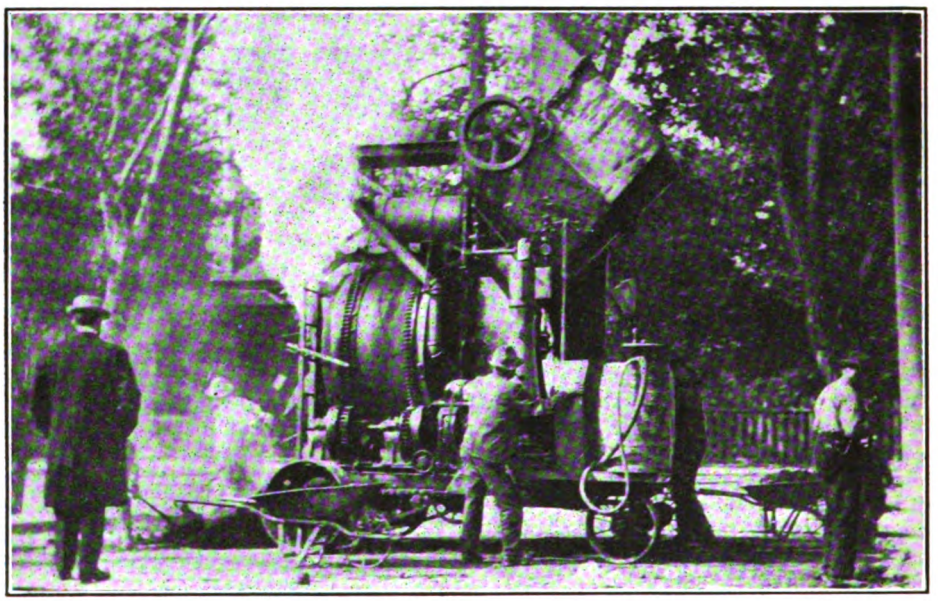
Salt Lake call for a heat between 200 and 250°F. On the day when the observation was made, the temperature of the batch, shortly after discharge, varied from 200 to 275°. After 8 minutes of heat (only 4 minutes was used at first), the cylinder discharges. The inspector then takes a temperature reading by inserting a thermometer in the top of the pile. The question has been raised whether this temperature as read fulfills specifications. Of course, it is evident that in heating by a direct flame some of the material is heated to a very much higher temperature than other portions, and that the temperature as taken can only be an average.

Dense volumes of smoke roll out of the cylinder, indicating the combustion of the valuable oils at this high temperature. This may have a great deal to do with killing the resiliency of the completed pavement, for it is the oil which gives resilience, and the natural asphalt will not well stand the high temperature of the blast.

The successive steps are spreading the asphalt sand, rolling with a hot hand roller, and finally, after cement has been sprinkled over the surface, the rolling with a 7-ton road roller. The pavement as completed has a 6-in. concrete base, and a 2-in. asphalt surface. The above is a description of the work now going on on Seventh East street, Salt Lake.

In laying the pavement, a crew of about a dozen men is employed, but with the intermittent operation of the heater, they have many idle moments. The present method of handling involves a great deal of hand labor and suggestions have been advanced whereby a heater which discharges continuously would be provided. With an efficient crushing plant and continuous heating, the cost of laying the pavement could be cut down largely.



CHARGING THE KOEHRING HEATER.

One ton of the asphalt sand lays about 12 sq. yd. of pavement.

One way suggested by which the cost of laying the pavement could be cut down, and the heating safeguarded, embodies a compact plant for crushing and heating. The crude material would be unloaded by hand and fed to rolls, thus reducing hand labor, the roll product going to Williams crushers. After crushing, the sand-asphalt would be elevated to a long cylindrical steam-jacketed heater, where superheated steam would provide a readily controlled and uniform heat, which would prevent all danger of burning.

As the men become more familiar with the Utah asphalt, better results are being obtained. Increasing the length of time of heating results in a better pavement.

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Hints on Practice

How to Set Up Wood Stave Tanks*

On the joists of the foundation structure, lay parallel sills from 12 to 24 in. centres, depending on the size of the tank. These sills are known as the chime sills. They should be designed to conform to the load and structural span under which the beam is to operate, and should not have a depth less than 4 in for 2 in. tanks, and 6 in. for 3 in. tanks. They should be cut so that when in position their ends lie within a circle which has a diameter about 3 in. less than the inside diameter of the tank. The staves must not be allowed to support any weight whatever; consequently the sills must be higher than the chime, which is that portion of the stave projecting below the tank bottom.

After laying the chime sills, put the tank bottom in place, using the dowel pins which are provided. Each bottom plank is numbered, and must be put in its proper position with the number on top. When the bottom planks are unusually long, they are made in two pieces, the parts to be joined together with an iron tongue. When the bottom planks are all in position, nail the cants securely to the adjoining planks. (The cant is the bottom plank having two edges, one edge being an arc of a circle, and the other the joint between the planks). Then open three or four joints adjoining each cant, about ⅛-in., holding them in this position with wedges or cleats tacked onto the bottom. The number of joints opened depends on the size of tank. A 30-ft. diameter tank would require about four spaces adjoining each cant, and smaller diameter tanks in proportion. Remove wedges when all staves are on and first hoop is connected. The object of spreading the bottom planks is to give the bottom a slightly larger circumference in order to get in a sufficient number of staves around the edge.

After putting the bottom in position, drive the first stave in slightly at the croze, and stay it with a brace running to the centre of the tank bottom. This stave should be plumb tangentially and lean outward a little at the top. After the first stave is driven in and stayed, the rest of the staves are then put in position, following around the circumference of the tank bottom, driving them in as little as possible, and every effort being made to get as much stave matter in as the circumference of the bottom will permit. Accompanying each tank are a number of staves on which lines are marked, to give the proper position of the hoops. These staves should be distributed at regular intervals around the tank.

The most frequent cause of leakage in tanks comes from making them too tight at first, and not putting in enough staves. The redwood used in tanks is very dry, and when it takes up water it must have room to expand. If the tank is too tight, the bottom will buckle and every joint will be strained. If there are not enough staves in the tank, the swelling of the bottom will force the staves out and open up the seams. When commencing to put up the staves, crowd them together as close sideways as is possible, and do not drive them onto the bottom any further than is necessary.

Experience has shown that it is seldom that two men will ever get in exactly the same amount of stave material around the edge, for the reason that one man may crowd his staves closer than another, consequently the manufacturers leave the last stave on the tank to be dressed to the proper width on the ground. Rip this last stave with a taper so that the width at the bottom end will be the same as the opening at the croze, and the width at the top end from 1 to 2 in. greater.

After the staves are all in position, it is well to stretch a rope around the tank to hold them in place while the hoops are being put in place. Each hoop is made up of two or more sections, depending on the size of the tank. Select the different sections which make up the combination, and place these around the tank, joining the ends together with the lugs. Always put in the bottom hoop first and follow with the others in regular succession. The three bottom hoops should be connected so that the lugs will not be closer than 4 ft., while the adjacent lugs on successive hoops should be spaced at intervals of two staves moving to the left. To keep the hoops from slipping down while sections are being connected, drive short nails at intervals around the tank.

Placing the lugs as suggested above

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will cause those above the bottom three hoops to wind spirally around the tank, provided rods of the same length are placed on the same side of tank. Under no circumstances snould the lugs be arranged so that one comes immediately above another. After the hoops are all on, and drawn snug enough to hold them in place, one man should go around outside of tank with a hammer and a block of wood and drive the staves home, applying the block directly over the croze. At the same time this is being done others should be tightening bands. When the staves are all tight on the croze, tank should be rounded out with a block and hammer, the tightening of the bands going on simultaneously. Should the staves spring back, drive them out again, and tighten up the bands. In tightening the bands, do not draw too much at a time, but keep going from one nut to another, taking up a little each time. It would be well to go over the hoops every day for two or three days taking up any slack which might be found. As a rule, the hoops will loosen up a little after standing a day or so. Should any leaks develop, the swelling of the wood will soon cause these to stop. In a few days, if the tank has been properly erected, it will be tight and remain so under all conditions.

Taking down and resetting an old tank is a matter requiring very careful work. First number each stave in the order which it occurs, and likewise number the bottom planks, and mark the position on the bottom of the stave number 1, also the direction, by means of an arrow, in which the staves are numbered. Then gradually loosen the nuts on the hoops from top to bottom; then beginning with the top hoop, drop them off and tie together the various sections comprising each hoop. With a hammer and block, knock off the last numbered stave from the inside down near the bottom. Nail a short cleat along the edge flush against stave No. 1, so tnat when the staves are put back the position of No. 1 can be readily determined. Now knock off the rest of the staves in regular order and tie them in suitable bundles. One man should hold the stave while a second man is driving it out. Unless this is done the stave is apt to fall over and split off the chime.

Drive the bottom planks apart by means of a broad iron wedge such as an axe bit inserted in the cracks some distance from the outer edge. It is best to use two or three wedges, tapping them very gently. Putting together the bottom again is an easy matter. Getting in all the staves without trimming the last one is the problem. If the last straight stave is trimmed, the tank is apt to leak. In order to get all of the staves back again it is necessary to put the bottom together very loosely so that it has a larger circumference than when it was taken down. Therefore, leave some good-sized cracks in the bottom, holding them apart by means of wedges. Commence with stave No. 1, putting it against the cleat nailed along the edge, and follow with the other staves in regular order, making them fit as closely as possible. If the work is properly done, the last stave will fit in. If it does not, the bottom must be spread until it does. Now replace the hoops, tighten, and the bottom and sides will draw together as tightly as before.

Engineer's Note Book

Actual Value of Intercooling in Air Compression

By R. S. HOWARD

When guarantees of economic performance of any piece of power machinery are made, the guaranteed results are always stated to be reached under certain definite and specified conditions. For instance, steam engine economy is stated with a certain steam pressure at the throttle, a certain vacuum at the exhaust, a certain load and a certain speed.

For air compressing machinery the air end is guaranteed to deliver a certain quantity of air against a certain discharge pressure at a certain speed, and measured at the temperature and pressure of the intake, the barometer reading being known. Also this is to be done with the horsepower exerted not exceeding a certain figure, when perfect intercooling is attained.

This matter of intercooling the air between the stages of compression is of extreme importance, because the horsepower is materially influenced by the degree of intercooling. The opportunity of intercooling in the one and only reason for multi-stage compression of air, and the benefits are two-fold.

First, intercooling reduces the temperature of the partially compressed air before

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it enters the next cylinder, and thus reduces the final temperature of discharge of this next stage. The compression of air from atmospheric to 100 lb. gauge pressure, starting from 60°F., results in a final temperature not far from 480 to 500°. When air is compressed to such a temperature as this there is danger of the carbonizing of the lubricating oil, and in large quantities, where the heat is not carried away, explosions of mixtures of air and oil are altogether too frequent.

If this work is done in two stages, with proper intercooling before entering the high pressure cylinder, the temperatures can be kept down to between 250 and 275°. The final temperature depends somewhat on the speed of the machine, as at high speeds the water jackets around the cylinder walls are not so effective as at slower speeds.

The other reason for stage compression and intercooling is to reduce the power required to compress the air. For instance, to compress 100 cu. ft. of air to 100 lb. gauge

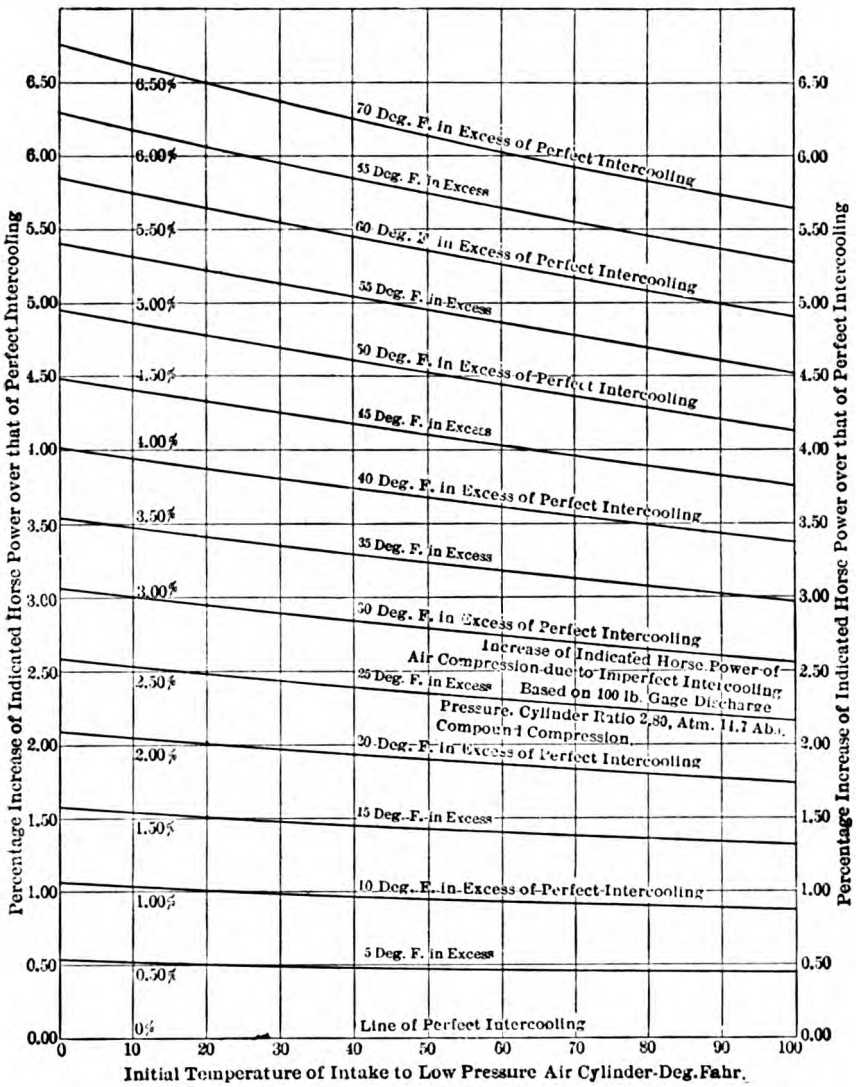

FIG. 1. INCREASE OF INDICATED HORSE-POWER OF AIR COMPRESSION WITH PARTIAL INTERCOOLING.

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pressure in one minute by single stage compression requires somewhat over 18 I. H. P. in the air cylinder, while if this is done in two stages of equal work, the horsepower will be about 15.5. This reduction in temperature is due solely to the cooling of the air, and the attendant reduction of its volume before it enters the second stage cylinder.

In order to make the saving above mentioned, it is necessary that the air shall be intercooled back to the temperature at which it first entered the low pressure cylinder. This is described as 'perfect' intercooling. The other extreme is no intercooling at all, which amounts to plain, single stage compression, irrespective of whether it was done in one cylinder or two. Between these two extremes lies the middle ground of partial intercooling, which is the condition most often met in practice. The degree of intercooling depends upon the area of the intercooler surface and the amount and temperature of the cooling water. The relative area of the cooling surface depends upon the quality of the machine; the finer the grade of machine purchased, presumably the greater the cooling area per cu. ft. of air compressed. Modern practice has greatly increased the cooling surface provided. The quantity and temperature of the cooling water are largely local matters, and are sometimes beyond control.

This last puts the air compressor performance somewhat at the mercy of local conditions especially the weather. For suppose, the intake air is at say 20°F. and the cooling water is at 35°; obviously no amount of cooling water will produce 'perfect' cooling, no matter how much cooling surface is provided in the compressor. In fact, with present day coolers of usual design, the temperature of the air leaving the intercooler can scarcely be colder than 20° above the temperature of the incoming water. Thus, with 60° atmosphere, 40° cooling water, and plenty of it, with adequate surface, the air would leave a properly designed intercooler at 60° and there would be a condition of 'perfect' intercooling.

Because such a thing is commercially possible, and is a standard base upon which to figure, air compressor builders always specify 'perfect intercooling' when guaranteeing horsepower requirements. The fact that local conditions so often limit the possibility of intercooling, renders it necessary in almost all cases of economy tests of air compressors to make a correction of the test figures for the actual cooling attained, in order to compare the results with the guaranteed figures. This process is not an easy one, and where there are several tests to figure, it becomes laborious and tedious, as well as a great consumer of valuable time.

This state of affairs is due to the apparently curious fact that, while with perfect intercooling the total horsepower of an air compressor is not affected by the temperature of the air it takes in, with imperfect intercooling the horsepower is affected by the temperature of the intake air. Thus with perfect intercooling, the horsepower of the air cylinders will be the same, no matter whether the air received is at 20° or 60° or 120° or any other temperatue, always assuming that the air entering the second stage is cooled back to the same temperature as that entering the first-stage cylinder. However, if the intercooling is, say, 35° short of perfect, so that if the fresh air is at 20°F. and that entering the second stage is at 55°F. the horsepower will be increased 3.42% whereas, if the initial temperature is 80°F. and the intercooling is only to 115°F., the increase in horsepower over perfect cooling will be only 3.07%. The reason for this is that the increase in horsepower is a function of the absolute temperature ratios, and the higher the temperatures are, a given difference of temperature makes a smaller ratio; thus, 20°F. is 481° absolute, and 55°F. is 516° absolute, so that their ratio is $516 \div 481 = 1.072$; while 80°F.= 541 absolute, 115 = 576 abs., their ratio being $576 \div 541 = 1.064$. The calculation is not nearly so easy as this, as it involves fractional exponents, and for accuracy requires the manipulation of at least five significant figures because of the small ratios involved.

Because the writer has had a great deal of this calculating to do, and because it is not only laborious and time-absorbing, but also difficult to perform accurately and consistently with a slide rule, by reason of the small ratios and fractional powers involved, the accompanying diagrams have been plotted. These give the percentage increase of indicated horsepower with various degrees of cooling, from perfect up to a discrepancy of 70° with intake temperatures from zero to 100°F. at the entrance to the low-pressure cylinder. In diagram given in Fig. 1, horizontal distances represent initial tempera-

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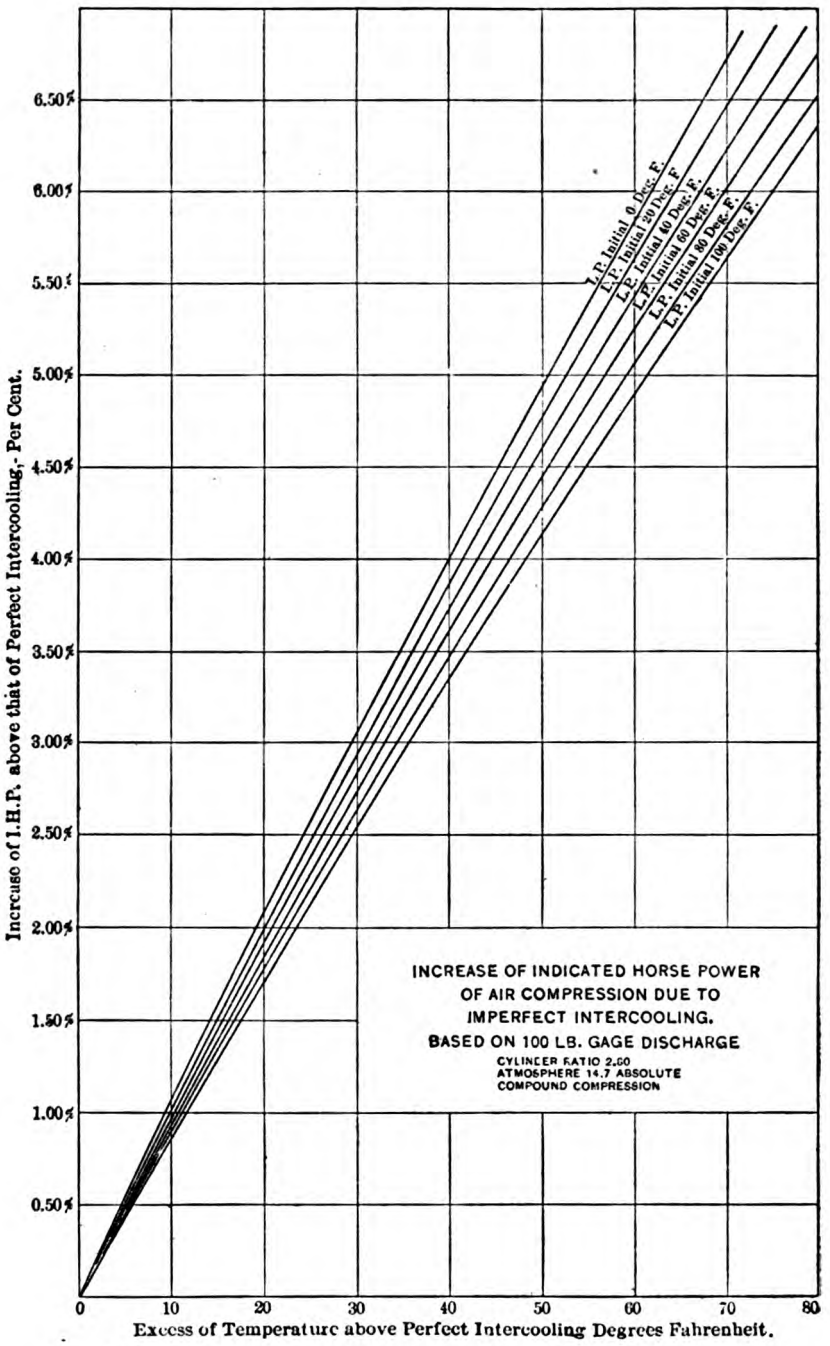

FIG. 2. INCREASE OF INDICATED HORSE-POWER OF AIR COMPRESSION DUE TO IMPERFECT INTERCOOLING.

tures at the entrance to the low-pressure cylinder, vertical distances represent the percentage increase of horsepower over that required with perfect intercooling, and the diagonal lines represent various excesses of temperature over and above the temperature of the intake to the low-pressure cylinder. Thus, suppose the low-pressure intake is at

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20°F., and the high-pressure intake is at 55°F.; then the 'excess of temperature above perfect intercooling,' as shown on the diagonal lines would be 55 less 20, or 35°F. If we enter the diagram at the line of 20° low-pressure initial temperature and follow it up to where it intersects the diagonal line corresponding to '35° excess,' we find the increase of I. H. P. is 3.42%, as previously stated. Also, as in our previous case, if the initial low-pressure temperature was 80°F., and the temperature of high-pressure intake was 115°F., the excess of temperature of the high-pressure intake was 115°F., the excess of temperature would again be 35°, and following the 80° initial temperature line up to its intersection with the diagonal line of 35° excess temperature, we find the increase of horsepower is 3.07 per cent.

The diagonal lines for excess temperature appear to be almost straight. As a matter of fact, the bottom line of no excess temperature is straight, of course, but it will be found by trial with a straight-edge that the lines become more and more curved the greater the excess temperature. The calculations have been carried only to an excess of 70° above perfect cooling, because excesses greater than this would seldom occur with modern designs, and certainly never would be allowed in any economy test.

For the practical use of the diagram in Fig. 1, let us suppose that the I. H. P. of a given compressor was found on test to be 432, and that when the test was made the low-pressure initial temperature was 33°F. and the high-pressure initial temperature 75°F. This gives an excess temperature of 42° with 33° initial, which we will find from the diagram to give an increase of I. H. P. of 3.97% above that which would be developed if the temperature of the high-pressure intake also had been 33°F., or a condition of 'perfect' intercooling. If these temperature conditions cause an increase of I. H. P. of 3.97%, the horsepower which the compressor would have required with perfect intercooling would be found by dividing its actual horsepower by 1.0397, or $(432 \times 100) \div 103.97 = 415.5$ I. H. P.

If the guaranteed figure had been not to exceed 417 I. H. P., the machine would have met the guarantee when the correction for intercooling was made, but would apparently have failed by 15 hp. if no corrections were made. This illustrates the importance of such a correction as this and the great necessity of having it accurate which, as said, is difficult with a slide rule. This and the fact that the results vary with every different intake temperature should make these curves of real practical value to all who have such work to do.

The curves have been plotted on an assumption of compression from atmospheric to 100 lb. gauge pressure in two stages, and with a cylinder ratio of 2.8, giving practically equal work in the two stages of compression. If the test pressure is other than 100 lb., and is not more than a few pounds out of the way, it is customary to make the pressure correction to 100 lb., and this should be done before correcting for intercooling. If the effective cylinder ratio is not exactly 2.8 (as it seldom is because of the use of convenient cylinder dimensions) the actual horsepower will be very slightly altered, but the percentage increase of horsepower for that particular pair of cylinders over perfect intercooling with the same cylinders, will be practically identical with the values given by the diagram.

As it is difficult to reproduce such diagrams on a magazine page to a sufficiently full scale, a condensed table of values is appended, from which it will be found easy to plot one's own curves to any desired scale. The values have all been obtained by long-hand calculation, using never less than five significant figures and six places of logarithms.

CONDENSED TABLE SHOWING INCREASE OF I. H. P. OF AIR COMPRESSION DUE TO IMPERFECT INTERCOOLING.

Compound compression from atmospheric to 100 lb. gage pressure. Cylinder ratio, 2.8.

Initial temp. of l.-p. cyl. Deg. F.	Excess of temp. above perfect cooling. Deg. F.	Temp. of air entering h.-p. cyl. Deg. F.	Increase of total I. H. P. %
20	0	20	0.0
60	0	60	0.0
100	0	100	0.0
20	10	30	1.014
60	10	70	0.929
100	10	110	0.867
20	20	40	2.006
60	20	80	1.864
100	20	120	1.728
20	30	50	2.057
60	30	90	2.734
100	30	130	2.558
20	50	70	4.776
60	50	110	4.447
100	50	150	4.136
20	70	90	6.473
40	70	110	6.257
60	70	130	6.019
100	70	170	5.648

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In this table only a few values are given, but by plotting these values, first as in Fig. 2 and then as in Fig. 1, all the intermediate points in each diagram may be plotted into the other diagram, finally arriving at such a set of curves as that shown in Fig. 1. In such a form it is possible to include all intermediate values because of its open construction; while Fig. 2, although giving to the eye perhaps a better mental picture of conditions than Fig. 1, does not admit of any more intermediate values without undue crowding.

It is interesting to note that with no intercooling at all, the excess horsepower is close to 18 per cent. At first thought it would seem that this percentage would vary with different low-pressure initial temperatures, but this means only that with different initial temperatures it requires a different number of degrees excess temperature to represent no intercooling at all, and these different excesses of temperature all correspond to about 18% excess horsepower, and again correspond to the respective initial temperatures.

Another, visual, effect of defective intercooling is the raising of the intercooling pressure. This is due to the increase of volume of the warmer air entering the high-pressure cylinder, and it is this increase of pressure and increase of volume of air handled that increases the horsepower.—*Industrial Engineering and Engineering Digest.*

Discussion

Hangman Creek Bridge, Spokane

The Editor:

Sir—In Volume 3, No. 5, page 331, a statement is made of the completion of Hangman Creek bridge at Spokane, Washington. The total cost is given at $120,000, giving a 7-arch bridge, 150-ft. centres, requiring 35,000 yd. of concrete to be built for this sum. It seems to us there may be a typographical error in the amount of $300,000. Kindly advise if we are correct in assuming this.

LEHIGH PORTLAND CEMENT CO.,
ERNEST ASHTON,
Chemical Engineer.

Chicago, Illinois, Dec. 1, 1913.

The error is obvious, and as Mr. Ashton states, is in the amount of about $300,000, the total cost of the bridge having been, in round numbers, $440,000. In order to obtain the exact figures, we have referred the question to Mr. Morton Macartney, city engineer for Spokane, to whom we are indebted for the letter following:

The Editor.

Sir—Replying to yours of the 4th, I beg to state that the Hangman Creek bridge, or Latah Creek bridge, cost approximately $440,000. The bridge is 1043 ft. long; is of reinforced concrete; 4 ribs, the roadway being 45 ft., with 7-ft. sidewalks on each side, and an over-all dimension of 60½ ft. Its greatest height is 130 ft.; approximate total yardage of concrete was 40,000 yards. The bridge consists of two 54-ft. arches, one 128-ft. arch, two 135-ft. arches, and two 150-ft. arches. It is paved with creosoted wood blocks, 12-lb. treatment. The roadway has a grade of 1%; carries a double car-track line; was constructed by J. E. Cunningham, the contract price being $416,000, to which with extras, engineering, and supervision, bring the total cost to the above-mentioned figure. The contract for the bridge was let in October 1911, and the final estimate was passed in November 1913.

MORTON MACARTNEY,
City Engineer.

Spokane, Washington, Dec. 15, 1913.

Road Construction

The Editor:

Sir—In the Discussion section of your issue for December appears a letter dealing with the subject of road construction, to some of the statements in which I desire to take exception. The contentions set forth in the third paragraph of the letter are untenable in face of the facts. Cuts have been made and earth been placed in fills with excellent results where the right procedure has been followed, and every engineer with experience in road and street building will vouch for the fact that it is easier to make a new fill, and make it firm and solid, than it is to fill a pipe trench and made that solid even with a 4-in. concrete base 'bridging' it. The contention made in the fourth paragraph that a cement concrete base will bridge and sustain loads over the void places in the sub-grade is equally untenable, and any paved city street will bear witness to the fact that the concrete base is not strong enough to withstand the traffic imposed on it where it covers a pipe or

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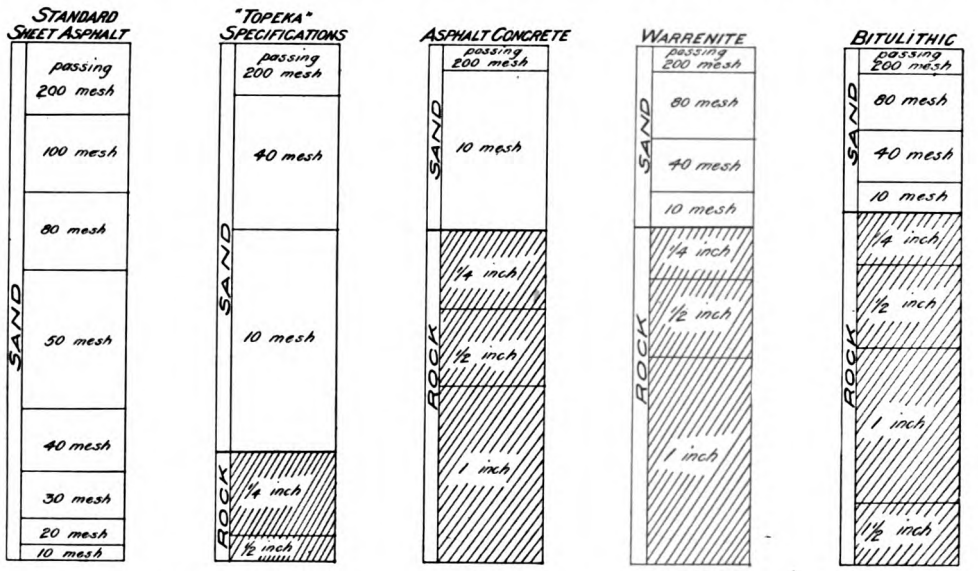
conduit trench. A well constructed base built of crushed rock of graded sizes will last as long as the sub-grade holds out, and a concrete base will do no more. An 'asphaltic concrete' base is in many respects superior to a cement concrete base. The soil in the sub-grade will not affect an asphaltic concrete, while dry and sandy soils during construction will absorb the moisture in cement concrete and thus materially affect its life. As an asphaltic concrete base is not subject to direct influence of the weather conditions, the cementing qualities do not decrease at all, and if they did, what would have become of the great deposits of bituminous rock here in California?

The fact that a few engineers have adopted cement concrete as a road surface is far from signifying that this is the last word in road surface construction. Nowhere has cement concrete for any length of time withstood ordinary traffic conditions. It shows not only a tendency to crack, but also to develop ruts like an ordinary dirt road.

The mixture called 'Topeka Specifications' absolutely is not an asphaltic concrete. It is a sand mixture, like a sheet asphalt, and a very poor sand mixture at that. It has nothing but a few (about 5%) ½-in. pieces of rock scattered through it, at no place within hailing distance of one another. The mass of sand, on account of not being graded like the sheet asphalt, is without proper density. This makes a very porous pavement, allowing rainwater to percolate through it and rot the asphalt. It is for this same reason without stability and will rapidly deteriorate; therefore, money spent on this kind of pavement is entirely wasted. An attempt has been made in certain parts of this state to introduce some useless patented machinery for the construction of this kind of work.

The diagram snows the five kinds of bituminous construction in use in California today which are made up according to the latest specifications and shows plainly the proportions of the different ingredients in each.



A study of the diagram will readily indicate that the difference between the 'Topeka' and a real asphaltic concrete is so great as to leave no doubt that the asphalt concrete, warrenite, and bitulithic show scientific grading of the materials and consequently all the characteristics of a real concrete with its inherent density and stability.

In paragraph ten of the letter some amusing statements are made. The facts as they exist today are such as to absolutely set them at naught. The squeegee coat of asphalt (so-called) and the stone chips all peel off so rapidly under traffic that it is evident that the item of maintenance is going to loom up considerably larger than was expected on roads with this kind of surface.

To sum up the situation, cement concrete is not the cure-all in road construction and never will be. It is impracticable as a road surface, as it is impossible to prevent incip-

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ient deterioration; it is inferior as a road base to both macadam and asphaltic concrete, as it does not last any longer than the sub-grade and lacks all capability of slight repairs which the two above mentioned possess in high degree.

GEORGE NELSON.

San Francisco, Dec. 15, 1913.

Book Reviews

AN ELEMENTARY TREATISE ON CALCULUS. By William S. Franklin, Barry MacNutt and Rollin L. Charles, South Bethlehem, Pa. For Sale by *Mining and Scientific Press*, San Francisco. Price $2.

For most of us the calculus is a closed book, or perhaps a more nearly correct statement would be that most of us regard it as a sort of question box into which a privileged few may drop inquiries and, by some mysterious and wholly uncomprehended process, obtain ready-made answers. Possibly the reason is that only a very few of us have studied the subject at all. Of that number by far the large majority worry along to obtain the kind of answers examiners require and eventually succeed in 'passing.' They may be likened to passengers in a railway train that runs through a crooked mountain tunnel; they plunge into a dark hole and after an interval spent in a smoky, dark, and uncomfortable atmosphere, they emerge, somewhat heated, with no true conception of how the passage has been accomplished. For the average engineer who has obtained his theoretical training in orthodox fashion the foregoing represents, fairly accurately, his remembrance of the hours spent in his study of the calculus. The very few who come to understand the subject are looked upon with marked respect, not to say reverence.

Some experienced thinkers on this subject, led by Professor John Perry have come to the belief that it really could be taught, not as a mental abstraction, but as a concrete reality. Perry himself has said that because of the false system of teaching such things, "Not one good engineer in a hundred believes in what is usually called theory"; and again, "A man learns to use the calculus as he learns to use the chisel or the file on actual concrete bits of work, and it is on this idea that I act in teaching the use of the calculus to engineers." His book, *Calculus for Engineers*, was the first evidence of new thought in this respect. It was so sane as to be taboo among the older disciples of pure mathematics. It had the temerity to depart from precedent and in consequence, and in due course, Professor Perry lost his official head. Incompetent neither as an egineer nor as a teacher, his downfall took time, but they got him in the end; and, now as before, professional mathematicians and the engineering students of England's foremost technical college are wallowing in the abstraction of those to whom their pure science is everything; the practical usefulness of that they teach is a by-product, and, as before, those who learn will do so in spite of their professors, not by their help.

The return to mediaeval methods was not accomplished without a row, more or less personal, into which three American professors in engineering, Messrs. Franklin, MacNutt, and Charles, of Lehigh University, entered with the zest of experience and the spice of humor. Their foreword, *Practical Mathematics**, provoked a hearty and sympathetic laugh from many who have reason to remember their own failures to understand the subject. Their book, is as practical a text book for students as its predecessors, and it will find as useful a place on the tables of working engineers, as a real hand book, a working tool. While some of the so-called classical applications of the calculus are to be found therein, there are also many extremely good applications, with reasonable assumptions as to known quantities, so that what Perry calls, "The common sense of an engineer," is not offended by the utter absurdity of the conditions of the problems, as stated. The plan of the treatise, as set forth by the authors, is based on the fundamental fact in nearly every case of application of calculus to engineering problems, three steps are involved, more or less interlinked, as follows: a statement of the problem, as differential equations, that is, the physical facts are expressed in the language of mathematics; a study of derivatives and of algebraic functions; practice in transforming derivative expressions into standard forms for identification leading to their solution. The book treats the subject along these lines in clear and workmanlike fashion. Not the least valuable part is an appended list of mathematical references covering a wide range.

We have neither the time nor the pa-

**Western Engineering*, Vol. III, p. 393.

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tience to trace in detail the differences between such teaching methods as these and those that in Professor Perry's case have been returned to vex young students. What if Perry's methods are deficient in pure theory in some minor respects. If they make for a real working knowledge of the calculus, their place as engineering studies is fixed satisfactorily, and those who thereby acquire a desire to go farther in the abstract will have less difficulty in comprehending the more exact methods they can acquire elsewhere, and no difficulty at all in separating the wheat from the so-called chaff.

Let no student, engineering or otherwise, imagine that any method as explained in any book can compensate for inadequate preparation of his subject. The calculus is a method of thought, not a slide rule. To apply it to any problem successfully is to think in its terms and according to its laws; and thought pre-supposes the things to think with—facts, and brains properly trained. Most students just out of college can solve for x and y, sometimes for z, too, when the equation is given them, even in complex form: they may wait years before they will have acquired the knowledge of nature's laws, and of the practice of engineering, so that their equations, when stated in the language of mathematics, will represent facts. The method of thought known as the calculus helps wonderfully, in certain cases, to secure accuracy and brevity, in such arguments. In special cases it makes possible solutions otherwise impossible, but its practical usefulness is founded first, last and all the time on the mental equipment and experience of the engineer who uses it. What folly then to think men with the gentle abstraction of the professional mathematician, can teach it successfully to those who have the rough and ready mental apparatus of the practical engineer.

Anyone who fails to get the real thought back of the last paragraph should ask both a professional mathematician and a practical engineer what is meant by the 'Fourth Dimension.' The first will have difficulty in expressing his abstraction; the second will confess, very likely, he has not much of an idea just what it is, but that if we had it we could do some supernatural stunts, and will name a few of them.

May Perry and his followers live long enough to see their enemies confounded.—A. H. Babcock.

Industrial Progress

Schaw-Batcher Pipe Works at San Francisco*

One of the largest manufacturers of riveted pipe on the Pacific Coast, equipped to handle tank, pipe, and other work requiring material ranging from No. 24-gauge galvanized iron to and including 1¼-in. plates, is the Schaw Batcher Company, situated at South San Francisco. To give some idea of its interesting arrangements, the accompanying plan has been sketched and a number of photographs have been reproduced.

The plant covers five acres of ground on the east side of the main line of the Southern Pacific railroad. It comprises a main building parallel to the railroad, with a spur track for the receipt of material and the despatch of finished products, and at opposite ends of the main building a north and a south building at right angles to the tracks and each extending over the spur track. The south end building is used for the storage of the steel plates, while in the other the material is finished and loaded on cars for shipment. The main building contains all the machinery in its main or central portion, which is 60 ft. wide. It is 250 ft. long, as are the east and west bays, the former 30 ft. wide, devoted largely to laying-out operations, and the west bay, 40 ft. wide, given over chiefly to making sheet metal products. The spur track is 800 ft. long, giving ample space for loading and unloading cars alongside the west bay as well as in the north and south buildings, through which the siding passes, as shown in the plan of the shops.

Crane facilities are, of course, important in a plant requiring the handling of heavy objects. Through the centre of the main building there are five overhead cranes of 40-ft. span with a clearance of 25 ft. from the floor-level. These crane runways are hung from the roof trusses and vertical columns extend below the level of the runways to support a supplementary runway in each case. This with a runway on the adjoining line of columns form the support for what may be called traveling trucks of 10-ft. span. The truck runways have a clearance of 14 ft. and likewise extend the full

*Abstract from *The Iron Age*, Oct. 2, 1913.

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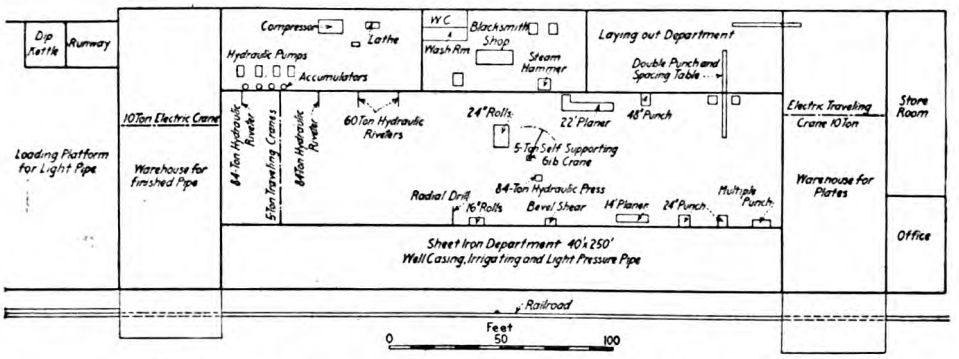
length of the building with six trucks on each of them. They are intended to support material under fabrication at the different machines. In addition to the trucks, swinging booms are installed at different machines to take care of extra long sheets under construction. Both the south and the north buildings are provided with a 10-ton electric traveling crane serving the entire building area, which is 48 by 160 ft., and also the spur track. In general, the cranes have pneumatic hoists of 5 to 10 tons capacity each.

In the course of construction, the plates



PLAN OF BUILDING AND ARRANGEMENT OF MACHINE TOOLS.

are taken from the south or plate storage building by the overhead crane and placed on a small flat car. They enter at the extreme end of the east bay, where they are picked up by another crane and placed on a spacing table and run through a double punch, one opposite the other. After punching for the roundabout joints, the longitudinal laps are marked and punched on single punches. The plates then pass to the planers or bevel shears to have the edges trimmed. The ends are then crimped under an 84-ton hydraulic press and swung over to a steam-hammer to have the corners scarfed out to a feather edge. They are then ready to be rolled into shape and the capacity of the rolls is 1½-in. plate. The plates, being rolled into shape, are riveted on the longitudinal seams by horizontal hydraulic riveters. There are two of these riveters, each of 60 tons rating. The pipe is then assembled into sections ranging in length from 8 to 30 ft. The girth seams are riveted by horizontal hydraulic riveters, of which there are two, of 84 tons each. After this operation the sections are dropped in the north shop, where they are calked and painted and made ready for shipment.

In the east bay of the main shop is the laying-out floor, the blacksmith-shop, and machine-shop. The west bay is devoted entirely to the manufacture of sheet iron pipe, well casing, smokestacks, dredge pipe, and light sheet iron tanks.

Air for the hoists, riveting and calking hammers and drills is furnished by a two-stage Franklin belt-driven compressor having a capacity of 619 cu. ft. of air per minute, with a final air pressure of 100 lb. In connection with the belt-driven compressor there is installed an auxiliary steam plant for emergency purposes.

The four hydraulic riveters are operated in connection with accumulators, each riveter having its own accumulator. The accumulators have the usual disks, allowing any number to be used, regulating the pressure to the requirements of the work. Each accumulator is connected to a double-acting belt-driven hydraulic pump. The pumps are connected by a valved manifold allowing pumps to operate with any accumulator. All the machines throughout the shop are direct connected, and the total power to run the plant is 400 horse-power.

A great deal of attention has been given to the lighting system of the plant, controlled from the switchboard in the engine-room, which is in the east bay of the main building. Mazda lamps were installed with Holophone D'Olier porcelain enamel steel reflectors, and range in size from 150 to 500 watts.

The specialty of the Schaw Batcher Company, which has offices at 356 Market street, San Francisco, is high-pressure riveted-steel

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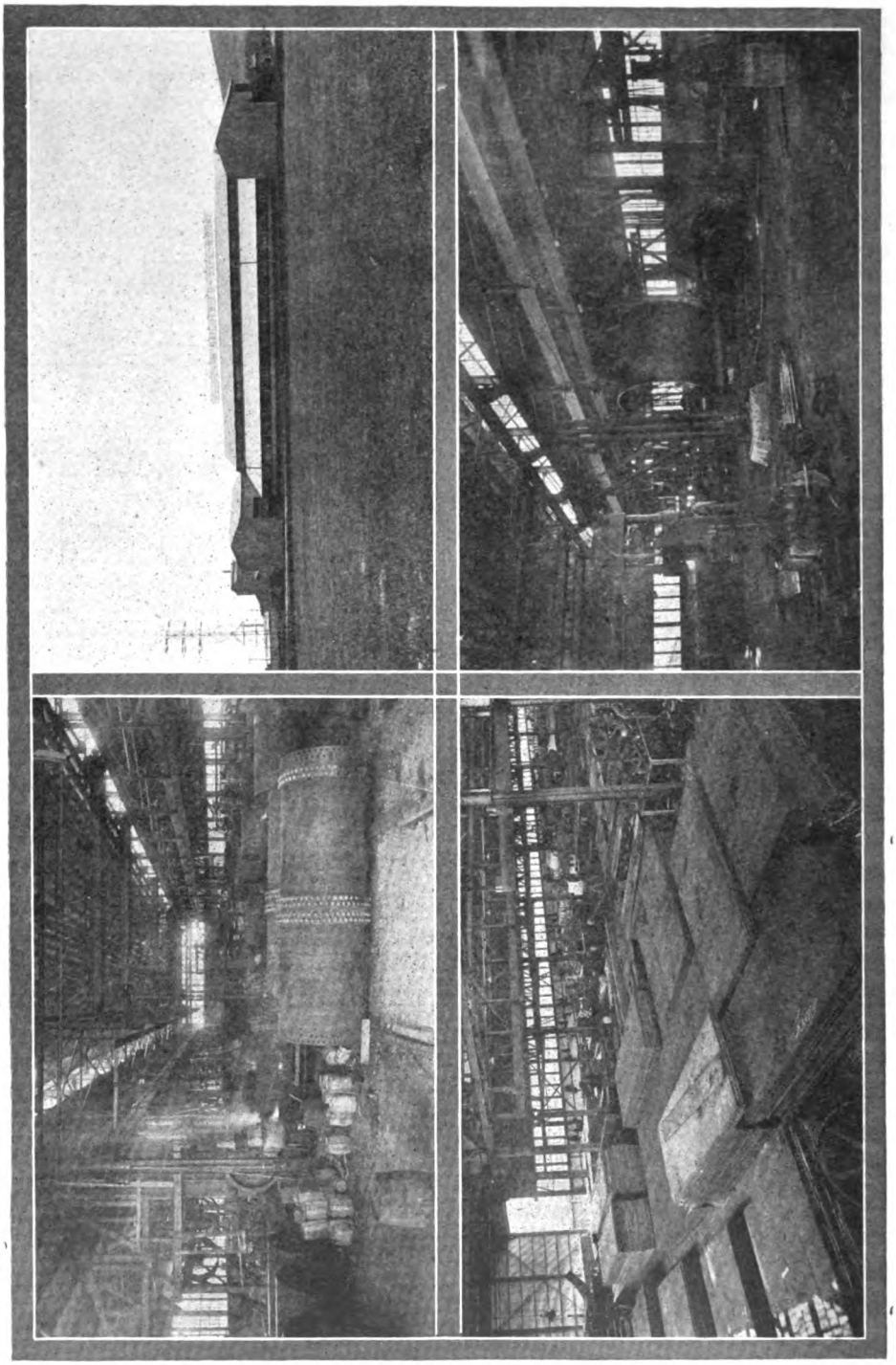

EXTERIOR OF PLANT.
ROLLING A SECTION OF LARGE PIPE.

CENTRE VIEW OF MAIN SHOP.
PLATES READY FOR FABRICATION.

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pipe. It also manufactures oil storage, cyanide and pressure tanks, gas holders, oil heaters, boilers, well casing and irrigating, air and light sheet iron pipe. The shop has recently completed a contract of 5000 tons of pipe for the Pacific Gas & Electric Co. for the Drum power project, the pipe varying from 52 to 102 in. diameter and from 1¼ to ¼ inch in thickness.

Company Reports

The Great Western Power Co. has issued the following statement of earnings for September and nine months:

Month of September, 1913:	
Gross operating income	$223,330.61
Operating expenses and taxes	93,397.34
Net operating income	$129,933.27
Other income	19,256.32
Net income from all sources	$149,189.59
Bond interest	98,766.67
Surplus for September 1913	$ 50,422.92
Surplus for September 1912	17,407.26
Increase 1913 over 1912	$ 33,015.66
Nine months ended Sept. 30, 1913:	
Gross operating income	$1,993,094.59
Operating expenses and taxes	687,517.25
Net operating income	$1,305,577.34
Other income	138,987.59
Net income from all sources	$1,444,564.93
Bond interest	861,579.72
Surplus for 9 months ended September 30, 1913	$ 582,985.21
Surplus for 9 months ended September 30, 1912	293,174.78
Increase 1913 over 1912	$ 289,810.43

The California Railroad Commission has granted authority to J. M. Vincent to increase the water rates in the town of Ceres, Stanislaus county.

The California Railroad Commission has issued an order dismissing the application of the Southern California Utilities Co. for authority to issue a note for one year in the sum of $50,000.

Engineering News

Petroleum

Los Angeles, Cal.—The usual dividend of the Union Oil Co. for January has been passed, but the directors have announced that in July, 1914, dividends will be resumed on a minimum basis of 4% per annum.

Oleum, Cal.—On December 9 the asphalt plant of the Union Oil Co. at this point was destroyed by fire at an estimated damage of $25,000.

Oakland, Cal.—On December 17 the principal portion of the plant of the Pacific States Oil Refinery at the foot of Fruitvale avenue was destroyed by fire.

Alameda, Cal.—The Electricity Commission has awarded a contract to the Standard Oil Co. to furnish the municipal electric light plant with oil for three years at a price of 80c. per barrel.

Santa Paula, Cal.—It is stated that the Santa Susanna Syndicate is contemplating the installation of a refining plant to handle the output of its wells.

Fellows, Cal.—The United Electric and Mercantile Co. is installing electric motors for pumping at the wells of the Olig Crude Oil Co. and the Combined Oil Company.

San Francisco, Cal.—The last month has marked a resumption of purchases of heavy oil. It is stated that the Standard Oil Co. has contracted with the Le Blanc Oil Co. for its output of heavy oil for three years. The Section 15 Oil Co. in the north Midway field has contracted with the Union Oil Co. for the sale of its storage holdings and regular production.——The Standard Oil Co. is reported to have purchased 1,000,000 barrels of heavy oil from the Reward Oil Co. in the McKittrick field.——The Northern American Oil Co. operating in the Midway district has contracted for the erection of two topping plants, one of 2000 barrels per day, and the other of 1000 barrels per day.——The Western Ocean Syndicate, Ltd., has been formed by Andrew Weir and his associates to effect the transfer of securities between the present General Petroleum Company's bond holders and the cumulative preference shares of the new company. The Mercantile Trust Co. of San Francisco is the depositary and the bonds must be deposited before March 31, 1913. The basis of exchange is £3 in ordinary shares of the English company for $100 par

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in the General Petroleum Company.——The Pacific Coast Steamship Co. has decided to equip all its vessels in the coast-wise trade with oil burning apparatus.——It is reported that the Standard Oil Co. is planning to establish five tank farms with a capacity of 1,000,000 barrels each for the storage of oil under 21.9° Baumé.——The Royal Dutch-Shell syndicate has asked for bids for 20 steel tanks of 55,000 capacity each.

Casper, Wyo.—The Pine Dome Oil Co. made up of Salt Lake people has filed articles of incorporation in Wyoming to develop and operate the oil fields of that state. The total capitalization is $2,500,000. The officers of the company are: John Dern, president of the company, and Lafayette Hanchett, vice-president, who, with Adrian Ellis and W. W. Armstrong of this city and Harry Hynds, R. W. Schenk, and Edwin Hall, of Wyoming, form the directorate. H. M. Byrne is the secretary and treasurer of the Company. Among the other local people interested are Mrs. W. V. Rice, W. H. Dickson, Duncan MacVichie, and Eugene Giles. Edwin Hall will be the superintendent for the Company, which has made arrangements to commence drilling immediately.

Miscellaneous Engineering Construction

San Francisco, Cal.—The Board of State Harbor Commissioners has called for bids for the construction of Pier No. 46, which is to be situated south of the Pacific Mail Docks and also for bids for widening piers 25 and 27 and laying spur tracks thereon.

Alameda, Cal.—The Public Utilities Committee of the City Council is considering plans for the improvement of Alameda harbor. $200,000 is to be expended for doing this work.

Berkeley, Cal.—The city has sold $475,000 of bonds for the construction of an intersecting, sanitary and storm-water sewer system, involving approximately 10 miles of concrete sewers, ranging in size from 2 to 8 ft. diameter, including three outflows in San Francisco Bay. It is the intention to award contracts for the work in amounts ranging from $30,000 to $75,000. Plans and specifications are now being prepared and it is proposed to have all the work completed within one year. J. J. Jessup is city engineer.

Richmond, Cal.—The City Council has passed a resolution providing for the sale of $300,000 additional harbor development bonds, bids for which are to be open January 12. This will make a total of $600,000 to provide funds for carrying on the work in contemplation.

Red Bluff, Cal.—All of the proposed bond issues for various civic improvements were defeated at a recent election, with the exception of that for sewers. This provides $8000 for additions to the present system.

Sacramento, Cal.—A suction dredge owned by the Natomas Consolidated has commenced work on the levee across the river between the Northern Electric and the Southern Pacific bridges for improving the river frontage owned by the West Sacramento Co. The levee is to be raised to the same height as the city retaining wall opposite.

Spokane, Wash.—Porter Bros., contractors of this city, together with a number of Canadian firms have been awarded contracts aggregating $5,000,000 for harbor improvements and a dry dock at Halifax, Nova Scotia.——Preliminary estimates have been completed by Morton Macartney, city engineer, showing that a concrete structure for a grade separation at Trent Ave. and Sheridan street from the tracks of the Inland Empire system, the Northern Pacific and Washington Water Power Co. will cost $235,000. The original grade separation plans called for a steel structure and a steel river bridge with earth approaches at a cost of $225,000. Under the new plan, which is favored by the City Council, that portion of Trent Avenue between the East and West bridges, will not be filled to the level of the grade separation structure as was first proposed. Instead a concrete viaduct will be built on the east end of the bridge to Decoto street, a distance of about 150 ft. and over a dirt fill will run east, reaching the present ground level at Hamilton street.

Seattle, Wash.—The Port Commission has adopted a resolution providing for the construction of a 500,000-bushel grain elevator on the East waterway. The site has been chosen and the money required is on hand, so construction work will begin at once.

Palouse, Wash.—The City Council has taken initial steps toward creating an improvement district for the construction of a sewer system which will accommodate all of the north part of town west of the I street

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sewer, which takes in the eastern portion of the city. J. M. McCaw is the engineer in charge of the work.

Kennewick, Wash.—The City Council has passed resolutions requesting the assistance and co-operation of the State Highway Commissioners for securing a preliminary survey for a wagon bridge across the Columbia river between Kern and Pasco.

Davenport, Wash.—The last of nine steel bridges erected by the Coast Bridge Co. of Portland has been accepted by J. L. Thayer, county engineer. These bridges were built at a total cost of $20,000. In all 24 bridges with spans varying up to 40 ft. were built at a cost of $14,000 while 20 reinforced concrete culverts were built at a cost of $6000. An appropriation of $45,000 has been made for bridge work in 1914.

Garfield, Wash.—The new trunk sewer and sub-sewer are completed. The cost of the former was $14,735 and the latter $6757. The system is equipped with a septic tank and filter that have a capacity of 8000 gal. per day. Outside bids were rejected and the entire project has been completed by day labor under the supervision of J. M. McCaw, city engineer.

Wallace, Idaho.—A contract has been let to Joseph Turner and T. H. Peeler, for the construction of a 605-ft. wing dam on the south fork of the Coeur d'Alene river, for the sum of $1058.75, or $1.75 per lineal foot.

Salt Lake City, Utah.—The City Council has passed an ordinance ordering the Oregon Short Line railroad to build a viaduct over its tracks on Third North street between Third and Fourth West streets.

Streets and Roads

San Mateo, Cal.—Highway bonds to the extent of $500,000 have been purchased by E. H. Rollins & Sons and Wm. R. Staats Co. These bonds carry 5% interest.

Yuma, Ariz.—Sealed proposals will be received by the Board of Supervisors of Yuma county, Arizona, until 10 a.m., January 10, 1914, for the furnishing of material, tools, equipment, labor, and for the improvement of public highways, for which a bond issue of $500,000 was authorized on September 27, 1913. E. H. Kellogg is county highway engineer.

Ashland, Ore.—Keasley & MacDowell, contractors for the mountain section of Jackson county new trunk highway, have established headquarters at this point. The first unit of the work will begin at Steinman, 10 miles from Ashland, where a camp is being established. The Siskiyou mountains will be crossed at an elevation of 4500 ft. Steamshovels and other heavy equipment have been ordered.

Wenatchee, Wash.—E. M. Gillette, chairman of the county commissioners, has stated that within two years a boulevard 40 miles long will extend the full length of the Wenatchee valley from Leavenworth to Colockum.——The work in contemplation for 1914 includes the link through Cashmere from Peshastin to Monitor and a large portion of the Sunset highway which is to be built by state aid.

Olympia, Wash.—The State Highway Commission has awarded contracts for work in eastern Oregon, totaling $120,000, as follows: Sunset highway, Lincoln county, Reardan to Davenport, 13 miles, $39,250, Henry Styles, Tacoma; Sunset highway, Lincoln county, Davenport west, for 2.2 miles, $18,700, Henry Styles; Pacific highway, Whatcom county, Blaine to Custer, 5.5 miles, $36,968.77, L. H. Goerig, Seattle; Sunset highway, Douglas county, Wenatchee northeasterly, 6.2 miles, $26,968.10, Rajotte & Fobert, Seattle.

Spokane, Wash.—The County Commissioners have announced that in 1914 13½ miles additional for the Palouse highway will be constructed, connecting Spokane with Rockford, and that 6½ miles additional of the Inland Empire highway north, connecting Spokane with Dennison, will also be completed. In all, 40 miles of macadam road will be laid in 1914, including: 10 miles of road, recently surveyed as a part of the Palouse highway, connecting the Moran prairie section of the highway with Rockford, the route to pass through Valleyford and Freeman; 6½ miles of the Inland Empire highway, connecting the North Wall street extension, or Waikiki road, with Dennison. It will also be possible to surface the Moran prairie road, 10 miles south of the city, which has already been graded by the Spokane Asphalt & Macadam Co., and to surface the 5 miles of road between Waverly and Spring Valley. The Costello company is now constructing 7 miles of the Inland Empire highway north, and the funds will be used to extend the road 6½ miles to Dennison, on the route to Deer Park. They will also be used to surface 6 miles of the normal road, near Meadow Lake, which has been

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graded by the townships. J. W. Strack is county engineer and C. A. McClung is chief deputy.——Revised plans for grade separation on Trent avenue at old Sheridan street have been submitted to the City Council by Morton Macartney, city engineer. The plans include the construction of a concrete viaduct to be built at an estimated cost of $225,000. There will also be required a concrete bridge across the river with concrete arches and a fill on the east, extending to Hamilton street and a fill with concrete retaining walls extending on the west to Grant street.——Petitions for paving the proposed arterial connection between Spokane and Hillyard via Illinois avenue and Fisk street are being circulated and a number of large property owners have already signed.

Salt Lake City, Utah.—P. J. Moran is making preparatory surveys on 11th East street and Highland Park drive, which are to be paved early in the spring.

Power, Gas, and Electricity

San Francisco, Cal.—The city engineer has recommended that power for the Union Street railway be bought from the Pacific Gas & Electric Co. at the price paid by the city for current used by the Geary Street road.

Quincy, Cal.—It is stated that the work of filling the earth dam for the Great Western Power Co. at the lower end of Big Meadows in North Fork canyon is practically completed. The dam is to be rip-rapped with heavy rock and the spillway will be constructed of concrete. As it now stands, the dam has a base about 600 ft. wide and the present height is 62 feet.

Salt Lake City, Utah.—It is stated that the Utah Power & Light Co. has acquired all of the $1,350,000 in bonds and practically all of the $1,000,000 stock of the San Juan Water & Power Co. This carries with it control of the Durango Gas & Electric Co. The San Juan company owns and operates several plants on the Animas river near the Denver & Rio Grande railroad in southwestern Colorado. It was organized in 1909 as a successor to the Animas Power & Water Co. This is regarded as a step toward the merging of a big power combination to be turned over to the Western Colorado Power Co., which was incorporated in March last.

Clarkston, Wash.—The Sturm railway has just closed a contract with the Lewiston-Clarkston company for securing electric power for the line to be built from Lewiston to Vineland.

Spokane, Wash.—The Cities Service Co., the Utilities Improvement Co., and the Consolidated Cities Light, Power & Traction of New York, otherwise known as the Doherty Syndicate, and of which the Spokane Falls Gaslight Co. of Spokane is a part, have been merged. This merger includes projects having a gross revenue of about $17,000,000.—— It has been announced that the Big Bend Light & Power Co. has sold its franchises and distributing systems in the Big Bend district to the Washington Water Power Co. The property conveyed includes the systems at Reardan, Davenport, Harrington, Ritzville, Sprague, and Lind. The proceeds of the sale, together with the other assets of the company will pay to the stockholders of the Big Bend Light & Power Co. a sum a little above par on their stock. When this has been done the company will be disincorporated. This property will be added to the lines of the Washington Water Power Co., which purchased on July 1 the business of the Idaho-Washington Light & Power Co., with headquarters at Moscow. This company also controls the St. Maries Light & Power Co. and the Palouse Light & Power Co.——The stockholders of the Washington Water Power Co. have authorized an increase in capitalization of $5,000,000, raising the total issue from $15,000,000 to $20,000,000. The bulk of these extra funds will be used for the purchase of the Long Lake power plant and a portion will be used for improving the plants purchased at Pullman, Palouse, Coulton, and Union Town, Washington; and Moscow, Troy, Saint Maries, and Genessee, Idaho.——Preliminary contours have been run for the proposed municipal power site at the Narrows near Fort Spokane. Morton Macartney is city engineer, J. B. Ingersoll is consulting engineer for the city, and Robert Crandall is assistant city engineer in charge of the work in the field.

Washington, D. C.—The President has issued an order creating a power site reservation in Boulder canyon on the Colorado river about 20 miles east of Las Vegas, Nevada. This reservation is created in order to permit applicants before the department to complete their former application for the right to develop water power under the

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water power laws. The proposed development includes a dam at the mouth of the canyon that will raise the water-level about 125 ft. and develop sufficient head for the production of about 40,000 hp. with the minimum flow of the stream, which is about 5000 second feet.——A permit has been granted by the Secretary of Agriculture to James Lindsay of Portland, Oregon, for the construction and operation of a power plant on Mill creek, Douglas county, Oregon, within the boundaries of Siuslaw National Forest. It is proposed to transmit the power a distance of 18 miles to Reedsport, Oregon, where it will be used for the manufacture of pulp.——A rock-fill dam about 30 ft. in height and 126 ft. in length is to be constructed at the outlet of Loon lake, which has an area of about 265 acres. The total estimated storage is about 4800-acre feet. The conduit will be four-fifths of a mile in length and will consist of wood-stave pipe about 5 ft. diameter. There will be installed three 1150-hp. horizontal Francis turbines which will operate under a head of 263 ft. and will be direct connected to three 750-kw. three-phase A. C. generators. The transmission voltage will be 22,000.

Irrigation and Water Supply

Riverside, Cal.—The following are the results of bids received for water works construction as being carried out under the direction of Burns & McDonnell, consulting engineers of Kansas City, Mo.: Contract No. 1, sheet iron pipe with valves and fittings: Baker Iron Works of Los Angeles, $218,880; T. J. Shea, Los Angeles, $199,901.85; Lacy Mfg. Co., Los Angeles, $193,587; contract awarded to Lacy Mfg. Co. Contract No. 2, reinforced concrete pipe, awarded to Arthur S. Bent Co., Los Angeles, $41,993.40. Contract No. 3, trenching, headwork, laying pipe, etc.: Johnson-Shea Co., Riverside, $44,553; Chambers & Heafery, Oakland, Cal., $57,658; J. T. Shea, Los Angeles, Cal., $39,715.35; Plummer Adams, Springfield, Mo., $66,700; awarded to Johnson-Shea Co. Contract No. 4, reservoirs and station buildings: Paul H. Ehlers, Los Angeles, $46,000; Arthur S. Bent Con. Co., Los Angeles, $40,500; Frank K. Benchley, Fullerton, Cal., $45,229; Fred Peter, Riverside, Cal., $49,200; Earl F. Low Co., Los Angeles, $38,975; Putnam Stone Con. Co., Pasadena, Cal., $41,618; Cresmer Mfg. Co., Riverside, Cal., $47,997; awarded to Arthur S. Bent Co. Contract No. 5, pumps and connections; all bids rejected. Contract No. 6, hydrants and valves: Mark Lally Co., San Francisco, $14,595.25; Chapman Valve Mfg. Co., Indian Orchard, Mass., $13,589.18; Darling Pump & Mfg. Co., Williamsport, Pa., $13,264.25; Waterworks Supply Co., Los Angeles, $15,126.96; Keystone Iron Works, Los Angeles, $19,700; Iowa Valve Co., Los Angeles, $13,712.06; Ludlow Valve Mfg. Co., Troy, N. Y., $15,201; M. Greenberg's Sons, San Francisco, $12,090.50; Columbian Iron Works, Riverside, Cal., $13,989; awarded to Columbian Iron Works. It was interesting to note that the total amount of the engineer's preliminary estimate was $312,314.60, and the total contracts and work let, as per final balance, amounted to $307,903.56, a saving of $4411.04 over the preliminary estimate.

San Francisco, Cal.—Stine & Kendrick have acquired control of the property known as the Chowchilla ranch, in the San Joaquin valley, including in all 108,000 acres. This acreage is to be subdivided, placed under irrigation, and colonized.

Richmond, Cal.—Engineers retained to report upon the Sacramento river as a source of available domestic water-supply have filed a preliminary report covering an estimated expenditure approximating $2,400,000, which, it is stated, will amply meet all the requirements during the next 25 years. Intake pipes and pumps similar to the system now in operation in the city of Sacramento are a part of the plan recommended. The proposed pumping plant will be placed at Toland's landing in Solano county.

Stockton, Cal.—At a meeting recently held, the members of the South San Joaquin Irrigation District have voted to issue bonds in the sum of $790,000 in order to secure funds for constructing a reservoir. The district comprises about 70,000 acres and has a total bond tax of about $54 per acre, which is payable in 30 years.

Sacramento, Cal.—The State Reclamation Board has postponed considering the application of the California Delta Association to prevent the diversion of the water of Kings river into the San Joaquin river, pending the report to be received from the engineers on January 20.——Application has been presented by H. L. Hale and L. A. Narres of Fresno for the formation of the Stinson-Burrell Reclamation District on the

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San Joaquin river. The area comprises about 1200 acres.——The application of Reclamation District No. 108, near Colusa, and containing about 53,000 acres, will be heard on January 20.——The following assessors have been appointed in the matter of the Knights Landing Ridge Drainage District: P. A. Haviland, P. Ashley, L. L. Hicock.——The flood-control engineer has been authorized to commence work on the preparation of the assessment roll for the 1,750,000-acre flood-control district.

Oroville, Cal.—Plans have been adopted for the formation of the Irrigation District Association and the following officers elected: R. S. Kitriek, of Oroville, president; J. M. Ward, of Oroville, vice-president; A. H. Davis, of Oroville, secretary-treasurer; Carleton Gray of Oroville, John Watkins of Wyandotte, N. B. Crane of Oroville, J. C. Henderson of Palermo, and above listed three officers, members of the board of directors.

Middletown, Cal.—A mass meeting has been held and a petition is being circulated for the formation of a Lake county water district to include Clear lake. The plans of the Yolo Water & Power Co., the Wheeler Water Co., and others are being contested in this way.——George L. Hoxie has inaugurated the formation of an irrigation project that will embrace approximately 235,000 acres. He has located 60,000 in. of water in the Sacramento river and proposes to divert it through a canal 40 ft. wide at the top and 20 ft. wide at the bottom, 9 ft. deep and 68 miles long, terminating on Stony creek, Glenn county.

Reno, Nev.—Nelson Bros., contractors, have been awarded the contract to build a cement canal 4 miles long, 6 ft. deep, 10 ft. wide at the top, and 7 ft. wide at the bottom, to conduct water from Washoe lake to supply various ranches in the valley.

Salt Lake City, Utah.—The Utah Conservation Commission has approved a survey whereby 100,000 acres of land in Tooele county can be supplied with water for irrigation purposes. Brown & Kleinschmidt, who have the contract for draining lands near Layton, have installed a trenching machine for digging trenches for tile drains.

Provo, Utah.—The Utah Lake Irrigation Co. has placed a contract with Owen H. Gray, of Salt Lake City, for the construction of three wood-stave siphons in connection with the company's irrigation projects; one from the Jordan river 2700 ft. long, one 500 ft. long at Jordan Narrows, and one 400 ft. long at Dry Creek near Sandy. The work is to be completed on April 1 and will cost about $10,000.

Spokane, Wash.—It is reported that the water main extensions in Burns addition and Glenwood park have been completed. The total length of pipe laid is 14,310 ft.; the total estimated cost, $14,644.45. A. Lindsay is water superintendent.

Pasco, Wash.—A committee of the Chamber of Commerce including Robert Jahnke, A. F. Wehe, and B. B. Harrigan, has been appointed to confer with E. McCullough at Sunnyside, who has been selected jointly by the Governor and the U. S. Reclamation Service to make a re-survey of the Palouse Irrigation Project.

Quincy, Wash.—The Quincy Valley Irrigation District, including about 400,000 acres in southern Grant county, has been organized with the following directors: E. I. Huffman, John A. Saboe, G. D. Banko.

Weiser, Idaho.—It is stated by A. H. Keller, cashier of the local bank, that ample funds are assured for the completion of the Crane Creek irrigation project. This project includes approximately 25,000 acres, and it is said that water will be delivered in the spring.

Railways

San Francisco, Cal.—According to Walter Arnstein, president of the Oakland, Antioch & Eastern railway, convertible loans have been secured in New York totaling $1,000,000 to provide funds for extensions and additional freight equipment.——A number of extensions are being planned for the San Francisco Municipal Railway. One is proposed to cross Golden Gate park at 10th avenue, along Kirkham street to 45th avenue, and thence to Sloat boulevard. A preliminary survey is to be made for the continuation of the 10th avenue branch of the Geary-street road through Golden Gate park.——F. S. Granger, of Fresno, is promoting a new electric interurban line from Fresno to Academy by way of Clovis. The new road will be known as the Fresno and Clovis interurban, and will have an original length of 24 miles.

Stockton, Cal.—I. L. Borden, of San Francisco, has applied for rights-of-way and franchises from the Board of Supervisors providing for the construction of a railroad

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through the island districts of San Joaquin and Contra Costa counties. Mr. Borden has agreed to pay one-third of the cost of construction of grading, not to exceed $5000, and to grant to the county a 200-ft. right-of-way across Victoria island. The projected railroad is to be built under the joint auspices of San Joaquin and Contra Costa counties, and will run from Holt, along Trapper's slough, and across Middle river to Victoria island and along the south bank of canal No. 1. As soon as the agreements for the deeds for right-of-way are filed with the supervisors, the county surveyor will be instructed to proceed with the surveys.

Dixon, Cal.—The town trustees have decided to grant a franchise for 50 years to the Sacramento Valley Electric Co. and to the Northern Electric Railroad Co. to build and operate an electric railway on First street, provided the Railway Commission will allow the crossing of the Southern Pacilc tracks in the northern part of the town to be made at grade. J. D. Rowrey and H. E. Brown for the Northern Electric Co., and Melville Dozier, engineer for the Sacramento Valley company, have gone over prospective routes and will report the results of their conclusions to the companies interested.

Los Angeles, Cal.—It is reported that the Southern Pacific Co. will build a new line from Mojave to Bakersfield as soon as necessary funds can be obtained.

Ogden, Utah.—The Oregon Short Line railroad has appropriated $90,000 for the extension of the tracks in the Ogden railway yards, so as to completely connect the old yards of the Union Pacific and the Southern Pacific. A. F. Brewer is superintendent of the Utah division of the Oregon Short Line. ——The Ogden Rapid Transit Co. has laid out a program for improvements for 1914 including the completion of the proposed extension of the Oregon Canyon line to Huntsville; the construction of the Logan line; installation of a new automatic block-signal system for the Canyon line, and putting P-A-Y-E cars on the city lines. P. D. Kline is general manager.

Salt Lake City, Utah.—The Salt Lake Terminal Co. has applied for a franchise to construct and operate all necessary tracks in connection with the joint interurban depot. This company plans to build a terminal for the joint use of the Salt Lake & Ogden railroad and the Salt Lake & Utah railroad. The tracks contemplated under the franchise will begin at North Temple and First West streets, extending south to Sixth South on First West; also from West Temple along Pierpont street to a junction with the First West tracks. A provision of the franchise is that nothing but electric power shall be used.

Provo, Utah.—The Central Utah Railroad Co. has filed articles of incorporation. This company is organized to construct a railroad from Salina, Sevier county, and easterly through Salina canyon for a distance of about 20 miles. Provo is the principal place of business. The officers and directors are: W. O. Creer, president; W. Allen Banks, vice-president; F. G. Warnick, secretary and treasurer; T. O. Creer and Heber C. Jex. The road will be built to open the coalfields east of Salina.

Pocatello, Idaho.—J. D. Browning, of Boise has applied for a franchise to build an electric railroad in Pocatello.——Ground has been broken by the Oregon Short Line railroad for a new reinforced-concrete building for housing the company's records. It is expected that a new depot at this point is to be constructed within a short time. Double tracking is progressing rapidly, and a new interlocking system has been installed.

Personal

B. S. JACOBSON has been appointed city engineer at Hillyard, Washington.

T. A. O'DONNELL has been made a director for the National Pacific Oil Company.

WILLIAM R. ROY has been appointed State Highway Commissioner for Washington.

M. M. O'SHAUGHNESSY, city engineer for San Francisco, has returned from Washington, D. C.

W. E. EARL has resigned his position as chief engineer for the California State Railroad Commission.

GEORGE WESTINGHOUSE has been awarded the Grashof medal by the Verein Deutscher Ingenieure of Leipsic.

P. T. HANSCOM has resigned his position as assistant to the president of the Great Western Power Co. of San Francisco.

CHARLES KIRBY FOX, consulting engineer of Pomona, California, has been in the Imperial valley on professional business.

L. L. DAGRON was one of a board to in-

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spect the new line of the Utah Light & Railway Co. from Salt Lake City to Bountiful.

THOMAS MORRIN, consulting engineer, has removed his offices from the Balboa building to 547 Phelan building, San Francisco, California.

R. W. PACK, of the United States Geological Survey, has been making a preliminary investigation of oil seepages at Thermalito, near Oroville, California.

H. A. REYNOLDS has been appointed county road commissioner, with headquarters at Walla Walla, Washington, to succeed J. N. MCCAW, who has resigned.

E. MCCULLOGH, of the United States Reclamation Service, has been inspecting reservoir sites for the Palouse irrigation project near Winona, Washington.

SYLVESTER Q. CANNON, city engineer for Salt Lake City, recently read a paper before the Utah Society of Engineers dealing with city water problems.

A. M. HUNT, consulting engineer of San Francisco, has returned from an Eastern trip made in the interests of the International Engineering Congress.

WALTER J. BARNHART, superintendent of the Lakeview No. 2 Oil Co., and of the Interstate Oil Co., has also been made superintendent for the El Dora Oil Company.

GUY A. HART, engineer in charge of the United States drainage investigation, has been in Huntington, Utah, supervising the installation of a cement-tile drainage system.

IRVING C. ALLEN, of the United States Bureau of Mines, is in San Francisco on business connected with the proposed petroleum exhibit at the Panama-Pacific Exposition.

A. H. BABCOCK, consulting electrical engineer for the Southern Pacific Co., recently addressed the students at Stanford University on 'Electrification Over the Tehachapi Pass.'

J. D. HACKSTAFF has been appointed general manager for the Southern California Gas Co., the Midway Gas Co., and the Northern Exploration Co., to succeed G. W. BARNES, who has resigned.

WILLIAM R. ROY, highway commissioner, JAMES ALLEN, chief engineer, and H. W. BOTZKES, assistant engineer, have been in Pasco, Washington, to inspect sites for preliminary surveys for bridges over the Columbia and Snake rivers at this point.

E. R. MORGAN, State Road Engineer for Utah, has returned from Boxelder county, where he was in conference with the County Commissioners with regard to surfacing the new road which is to be built between Bear River City and Tremonton.

A. H. DIMOCK, E. L. VAN EPPS, N. A. GILMAN, city engineers respectively for Seattle, Olympia, and North Yakima, Washington, and D. W. MCMORRIS, assistant city engineer for Seattle, have been inspecting the Spokane water-supply pumping stations as the guests of MORTON MACARTNEY, city engineer, and ALEXANDER LINDSAY, water superintendent.

HOWARD S. REED, formerly with the U. S. Geological Survey and the U. S. Reclamation Service, having been in charge of the operation and maintenance of the Salt River (Roosevelt) Irrigation Project in Arizona for the past six years, will engage in the general practice of engineering at Phoenix, with offices in the Noll building on North First avenue. Special attention will be given to municipal water works, design and construction of new or valuation of old systems; irrigation systems, design, construction, and operation, special attention given the organization of operation and maintenance departments; engineering reports on irrigation development, and valuation for bond houses, contractors, or prospective investors.

Obituary

JOHN O. HARRON, president of Harron, Rickard & McCone, of San Francisco, died on December 19, following an operation for appendicitis. Mr. Harron's death removes one of the notable figures in the Western machinery world. He commenced his business career as an apprentice at the Union Iron Works, and later became identified with the firm of Parke & Lacey, at that time one of the prominent machinery concerns of San Francisco. His advancement was rapid, and at the time of the death of B. P. Lacey, in 1901, Mr. Harron had become vice-president and general manager. He then associated himself with the late Thomas Rickard and A. J. McCone, and formed the firm of Harron, Rickard & McCone, under which name the business is still conducted, to take over the business of Parke & Lacey. Mr. Harron was 54 years of age and left a widow and one son.

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